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Current Science

Vol. 30, No. 7 JULY 1961 Pages 247-284

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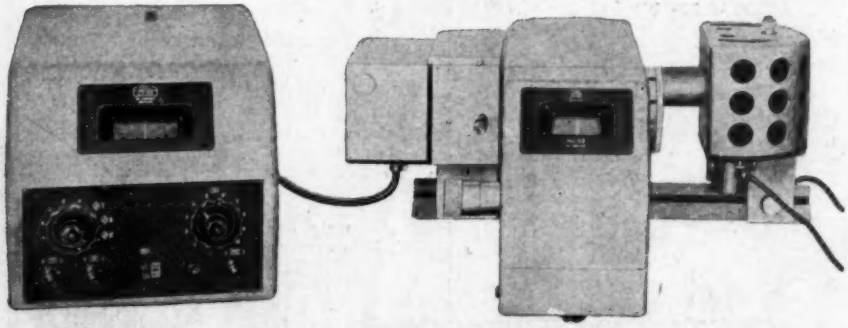

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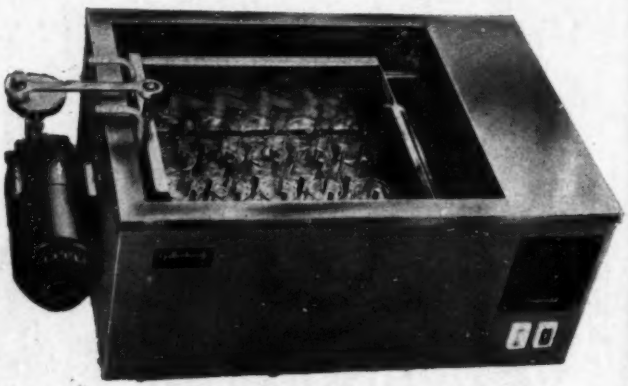

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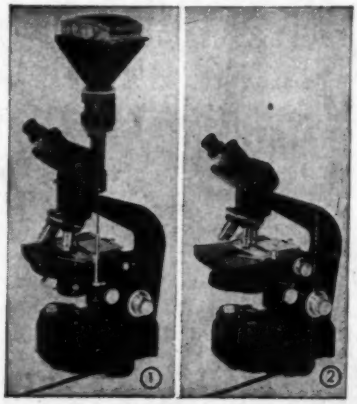

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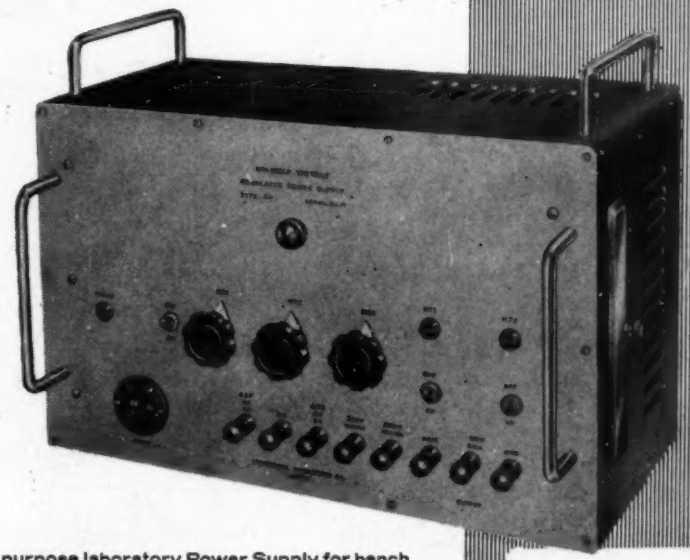

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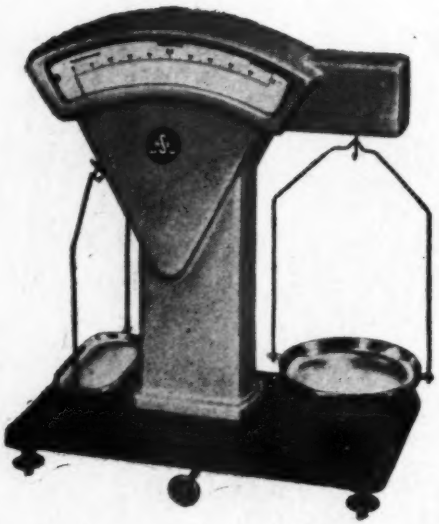

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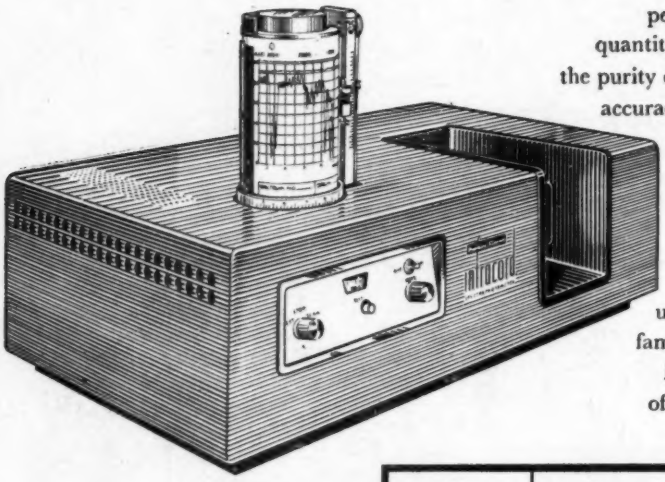

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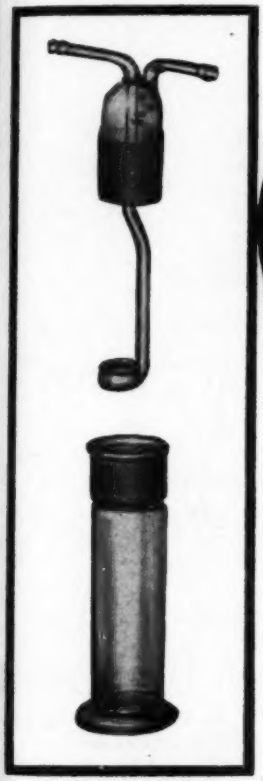

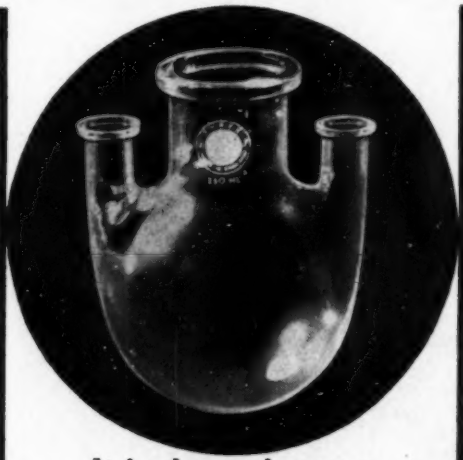

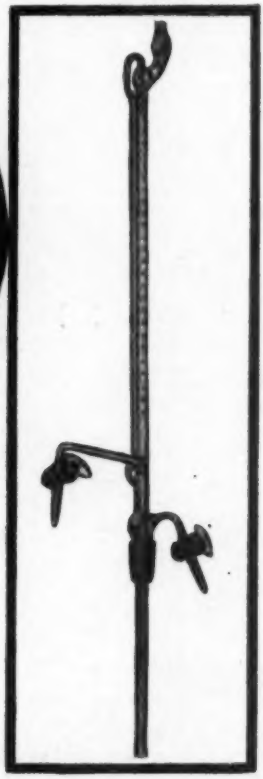

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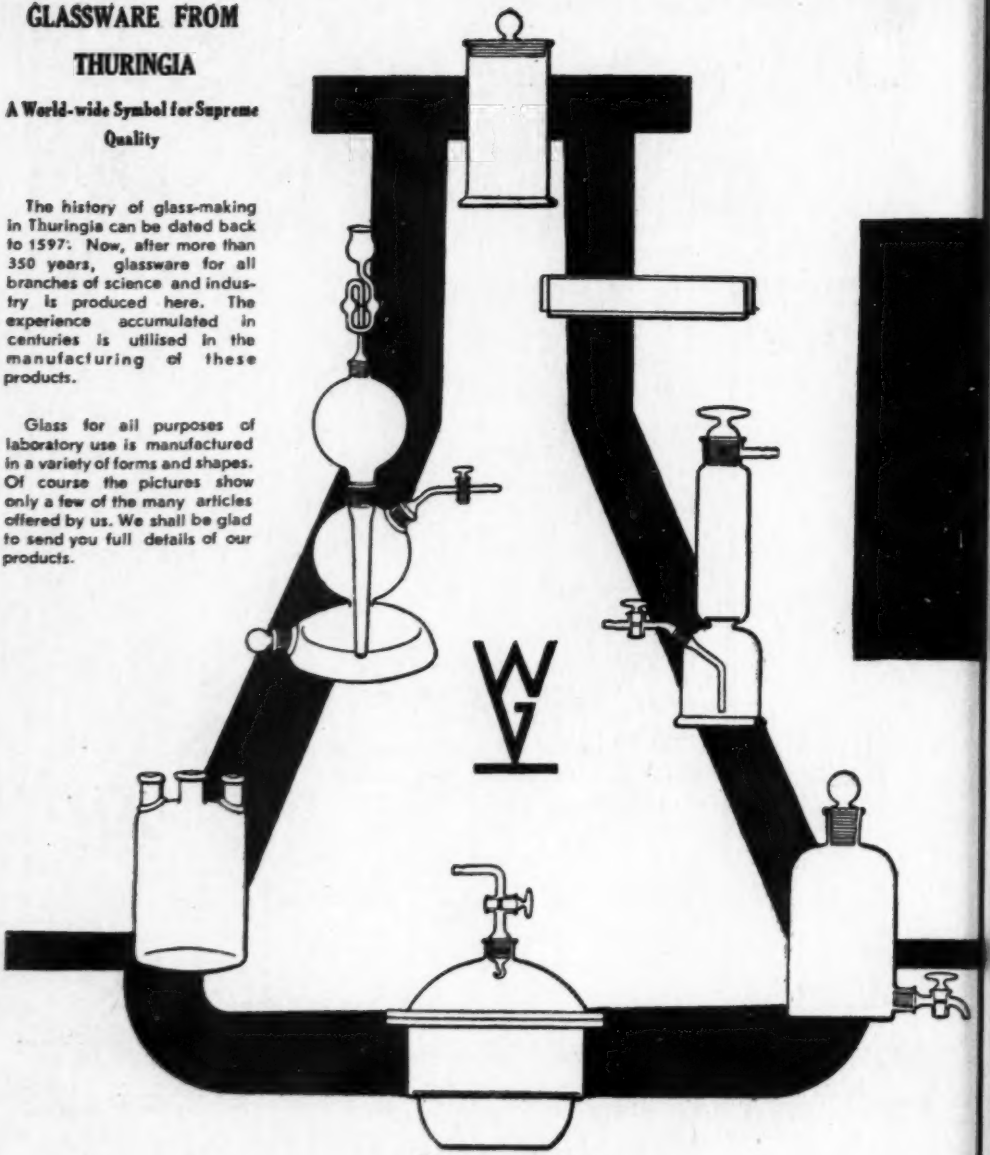

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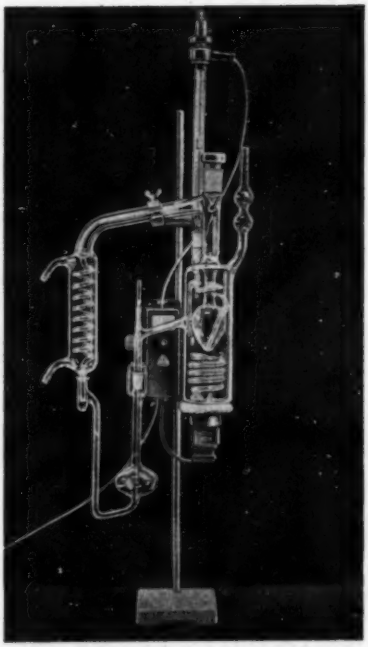

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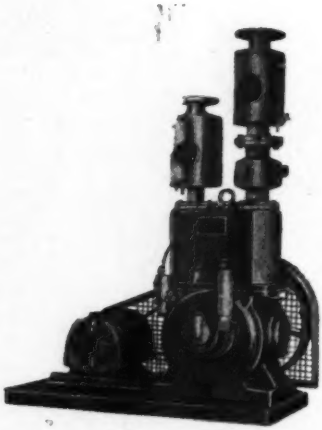

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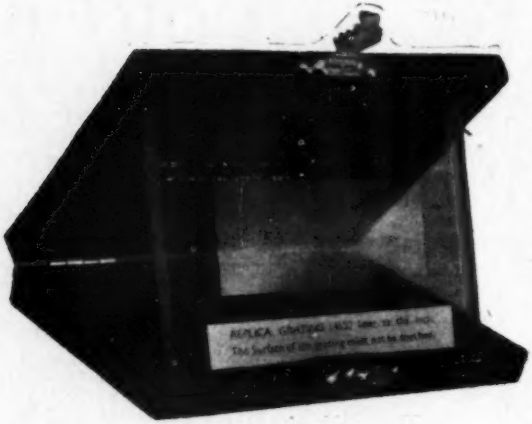

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APPRAISAL OF NEWTON'S MECHANICS AND OF EINSTEIN'S "AUTOBIOGRAPHY"

A. T. GRIGORYAN

IN 1949, Albert Einstein wrote for a Volume, devoted to his world outlook (Albert Einstein, Philosopher–Scientist, Illinois, USA, 1949), an article which contains a brief definition of the state of physics at the time he embarked on his creative work. On this occasion he appraised the principles of classical physics, those of Newton's mechanics.

At the turn of the century, the conception was still valid of Newton's laws of motion as being the final solution of the fundamental problems of being. "In the beginning (if there was such a thing), God created Newton's laws of motion together with the necessary masses and forces. This is all; everything beyond this follows from the development of appropriate mathematical methods by means of deduction" (p. 19).

According to Einstein, the XIX century provided sufficient grounds for such opinion of the Newton's laws of motion. Particularly striking were the successes achieved by the theories which applied the equations in partial derivatives. Newton's theory of the propagation of sound was the first classical example of applying such differential equations. Later Euler gave the differential equations of hydrodynamics. This belongs to the theory of propagation of deformations in a continual medium. According to Einstein, the XIX century was noted for a systematic and detailed study of the motion of discrete bodies, the mechanics of the latter forming the basis of physics as a whole.

When Einstein became acquainted with the principles of classical physics, he was most impressed not so much by the structure of Newton's mechanics and the methods of solving mechanical problems, as by the application of mechanics to proper physical and physico-chemical problems. Einstein enumerates the results of applying mechanical conceptions in physics: optics as the mechanics of quasi-elastic ether, the kinetic theory of gases and atomistic chemistry (which, however, stood quite apart in the mechanical natural science of the XIX century).

Einstein wrote about himself and his student years comrades: "What made the greatest impression upon the student, however, was less the technical construction of mechanics or the solution of complicated problems than the achievements of mechanics in areas which apparently had nothing to do with mechanics: the mechanical theory of light, which conceived of light as the wavemotion of a quasi-rigid elastic ether, and above all the kinetic theory of gases: the independence of the specific heat of monatomic gases of the atomic weight, the derivation of the equation of state of a gas and its relation to the specific heat, the kinetic theory of the dissociation of gases, and above all the quantitative connection of viscosity, heat-conduction and diffusion of gases, which also furnished the absolute magnitude of the atom. These results supported at the same time mechanics as the foundation of physics and of the atomic hypothesis, which latter was already firmly anchored in chemistry. However, in chemistry only the ratios of the atomic masses played any rôle, not their absolute magnitudes, so that atomic theory could be viewed more as a visualizing symbol than as knowledge concerning the factual construction of matter" (p. 19).

Classical mechanics may serve as the basis of thermodynamics. True enough, this requires a statistical assembly of molecules whose motions are subordinated to the relationships of thermodynamics which are backed by the immutable laws of motion and collision of bodies established by Newton's mechanics. That is why classical thermodynamics was regarded, and indeed was, a testimony of the universal nature of Newton's mechanics. Einstein wrote that ".... it was also of profound interest that the statistical theory of classical mechanics was able to deduce the basic laws of thermodynamics, something which was in essence already accomplished by Boltzmann" (pp. 18-20).

Newton's classical mechanics was considered to be the basis of electrodynamics as well. This quite naturally resulted from the universal interpretation of classical mechanics. Maxwell's and Hertz's deliberate tendency was to substantiate electrodynamics from a mechanical standpoint. At the same time the objective historical tendency, which forced its way in classical electrodynamics, consisted in refusing to accept classical mechanics as the basis of physical ideas.

Einstein wrote: "We must not be surprised, therefore, that, so to speak, all physicists of the last century saw in classical mechanics a firm and final foundation for all physics, yes, indeed, for all natural science, and that they never grew tired in their attempts to base Maxwell's

theory of electromagnetism, which, in the meantime, was slowly beginning to win out, upon mechanics as well. Even Maxwell and H. Hertz, who in retrospect appear as those who demolished the faith in mechanics as the final basis of all physical thinking, in their conscious thinking adhered throughout to mechanics as the secured basis of physics" (p. 21).

Einstein perceived a deliberate revision of classical mechanics in Mach's work, *History of Mechanics*. Here one has to differentiate strictly: (1) The idea that it is impossible to erect the building of science on the foundation of classical mechanics: (2) The so-called Mach principle according to which inertia forces are a function of the interaction of masses; (3) Mach's philosophical views.

As to refusal to accept a dogmatic and universal comprehension of classical mechanics, Einstein read in the *History of Mechanics* more than it contained; Mach disputed the idea of absolutely accelerated motion in the way it was expounded in Newton's "Principles". The famous example of the revolving bucket appeared unconvincing to Mach. But his remarks did not imply, even in a vague form, the notion of other, non-classical regularities of mechanics and did not lead to the assumption of non-mechanical initial regularities of nature.

As to the philosophical ideas of machism, Einstein felt their influence in his youth, but later he consistently departed from Mach's positions to an ever-increasing extent until he passed his well-known remark about Mach as the "déplorable philosopher".*

In his criticism of Newton's mechanics, Einstein proceeded from criteria fundamentally different from those of Mach. For Einstein, the first criterion of any physical theory consisted in its conformity with the results of an experiment, by which Einstein meant cognition of the objective processes in nature. *Physical theory should conform to experiment.* But this is far from warranting directly the correctness of the theory; the results of an experiment may conform to various conceptions, and a current conception can very often be brought to accord with an experiment by means of additional hypotheses. As a matter of fact, a conception which explains a number of experimental results in a non-contradictory way does not yet possess warranted oneness, since it can be replaced by another, sometimes more general, conception which accounts for a wider range of facts.

The case in point is, however, not the extension, precise definition and generalization of the theory in connection with transition to another wider range of phenomena. "Of the 'realm' of theories I need not speak here, inasmuch as we are confining ourselves to such theories whose object is the totality of all physical appearances" (p. 23).

Hence Einsteins's first criterion admits of but one alternative appraisal: the theory in question either accords or does not accord with the *totality* of known physical phenomena. Naturally enough, such a conformity cannot be guaranteed for the future as the volume of empirical physical knowledge constantly increases. It is precisely for this reason that the criterion of conformity with facts (Einstein called it the criterion of "external justification") is always valid in assessing a scientific theory.

The second criterion was termed by Einstein the criterion of "inner perfection". This implies the following:

Every theory can be defined, sometimes by intuition, and sometimes in a comparatively strict way, by the degree of its logical harmony. Einstein formulated this criterion very cautiously, pointing to its inaccuracy.

"The second point of view is not concerned with the relation to the material of observation but with the premises of the theory itself, with what may briefly but vaguely be characterized as the 'naturalness' or 'logical simplicity' of the premises (of the basic concepts and of the relations between these which are taken as a base). This point of view, an exact formulation of which meets with great difficulties, has played an important rôle in the selection and evaluation of theories since time immemorial" (p. 23).

This criterion should not be reduced to determining the number of independent assumptions from which the theory proceeds. Einstein wrote about the non-comparability of the logical "quality" of one theory with that of another competing theory. Apart from a number of independent premises, their "strength" is of importance, *i.e.*, the possibility of determining unambiguously the resulting assertions, with the exclusion of others.

"The problem here is not simply one of a kind of enumeration of the logically independent premises (if anything like this were at all unequivocally possible), but that of a kind of reciprocal weighing of incommensurable qualities. Furthermore, among theories of equally 'simple' foundation that one is to be taken as superior which most sharply delimits the

* E. Meyerson, *La déduction relativiste*, Paris, 1925, p. 62.

qualities of systems in the abstract, *i.e.*, contains the most definite claims" (p. 23).

Yet another component, "inner perfection," is added to the "naturalness" (logical simplicity) of the theory. The theory is more perfect if it has been selected with maximum compulsion and with least arbitrariness.

"The following I reckon as also belonging to the 'inner perfection' of a theory: We prize a theory more highly if, from the logical standpoint, it is not the result of an arbitrary choice among theories which, among themselves, are of equal value and analogously constructed" (p. 23).

Einstein did not claim that he formulated his criteria in a precise manner: "The meagre precision of the assertions contained in the last two paragraphs I shall not attempt to excise by lack of sufficient printing space at my disposal, but confess herewith that I am not, without more ado (immediately), and perhaps not at all, capable to replace these hints by more precise definitions. I believe, however, that a sharper formulation would be possible. In any case it turns out, that among the "augurs" there usually is agreement in judging the 'inner perfection' of the theories and even more so concerning the 'degree' of external confirmation' (pp. 23-25).

Einstein used the said criteria, above all, in tackling the question: can classical mechanics serve as the basis of physics as a whole? "External justification" for it becomes questionable in optics. First of all, the mechanical pattern of ether was in contradiction to the facts. The history of the theory of ether culminated in finally discrediting the mechanical models of ether. Maxwell's electrodynamics and Hertz's experiments which confirmed it were the decisive argument to shake the traditional appraisal of mechanics as the basis of physics.

The mechanical interpretation of Maxwell's electrodynamics became increasingly difficult as the processes in which weighable masses took no part proved to be the objects of electrodynamics. At the same time such an interpretation became less and less fruitful.

"... thus mechanics as the basis of physics was being abandoned, almost unnoticeably, because its adaptability to the facts presented itself finally as hopeless since then there exist two types of conceptual elements, on the one hand, material points with forces at a distance between them, and, on the other hand, the continuous field. It presents an intermediate state in physics without a uniform basis for the entirety, which although unsatisfactory is far from having been superseded" (p. 27).

The main substance of the definition of Newton's mechanics in Einstein's *Autobiography* is related, however, to the criterion of "internal perfection". Here the target of criticism is supplied by the basic conceptions of The *Mathematical Principles of Natural Philosophy*. As a matter of fact, the criterion of "internal perfection" is related to the initial precepts of the Theory and the special case, motion by inertia, cannot be singled out in this case. If we recollect what Einstein said about the criterion of "internal perfection", we understand why it is applied to the principles of the theory of motion in a general case, *i.e.*, the theory of accelerated motion.

Newton associates accelerated motion with absolute empty space and perceives proof of the absolute nature of accelerated motion in the appearance of inertial force. Let us remind the reader the lines from the "Principles", which outline this conception.

"The effects, which distinguish absolute from relative motion are, the forces of receding from the axis of circular motion. For there are no such forces in a circular motion purely relative, but in a true and absolute circular motion, they are greater or less, according to the quantity of the motion. If a vessel, hung by a long cord, is so often turned about that the cord is strongly twisted, then filled with water, and held at rest together with the water; after, by the sudden action of another force, it is whirled about the contrary way, and while the cord is untwisting itself, the vessel continues for some time in this motion; the surface of the water will at first be plain, as before the vessel began to move: but the vessel, by gradually communicating its motion to the latter, will make it begin sensibly to revolve, and recede by little and little from the middle, and ascend to the sides of the vessel, forming itself into a concave figure (as I have experienced), and the swifter the motion becomes, the higher will the water rise, till at last, performing its revolutions in the same times with the vessel, it becomes relatively at rest in it. This ascent of the water shews its endeavour to recede from the axis of its motion; and the true and absolute circular motion of the water, which is here directly contrary to the relative, discovers itself and may be measured by this endeavour. At first, when the relative motion of the water in the vessel was greatest, it produced no endeavour to recede from the axis: the water shewed no tendency to the circumference, nor

any ascent towards the sides of the vessel, but remained of a plain surface, and therefore its true circular motion had not yet begun. But afterwards, when the relative motion of the water had decreased, the ascent thereof towards the sides of the vessel proved its endeavour to recede from the axis ; and this endeavour shewed the real circular motion of the water perpetually increasing, till it had acquired its greatest quantity, when the water rested relatively in the vessel. And therefore this endeavour does not depend upon any translation of the water in respect of the ambient bodies, nor can true circular motion be defined by such translations. There is only one real circular motion of any one revolving body, corresponding to only one power of endeavouring to recede from its axis of motion, as its proper and adequate effect : but relative motions in one and the same body are innumerable, according to the various relations it bears to external bodies, and like other relations, are altogether destitute of any real effect, any otherwise than they may perhaps participate of that one only true motion" (Sir Isaac Newton, *The Mathematical Principles of Natural Philosophy*, London, 1803, pp. 11-12).

The appearance of inertial force means that the basis of classical mechanics, the principle according to which acceleration depends on the interaction of bodies, has been disturbed.

By calling inertia a force, we have retained the connection between the acceleration of bodies (caused by acceleration of a system and proving the absolute nature of this acceleration) and the "force", but the latter no longer expresses the interaction of bodies.

By declaring the interaction of masses to be the cause of inertial forces, Mach wanted to save the basis of classical mechanics, the dependence of acceleration on such interaction. In essence, he came out against Newton's absolute space from classical positions. Einstein initially considered "Mach's principle" a substantial element of the general theory of relativity. Later on he changed this appraisal. In his autobiography he wrote : "Mach conjectures that in a truly rational theory inertia would have to depend upon the interaction of the masses, precisely as was true for Newton's other forces, a conception which for a long time I considered as in principle the correct one. It presupposes implicitly, however, that the basic theory should be of the general type of Newton's mechanics : masses and their interaction as the original concepts. The attempt at such a solution does not fit into a consistent field theory, as will be immediately recognized" (p. 29).

The above lines are of primary historic significance ; they alone, regardless of the rest of the *Autobiography* contents, make it an important document of the history of science. Above all, the lines contain a summary assessment of Einstein's views on a highly important subject. It would be extremely significant task in compiling Einstein's scientific biography to trace the changes in Einstein's views on inertia as a function of mass interaction, and the connection between these views and cosmological ideas. As this has to do with the greatest physicist of the century, the task exceeds the limits of a scientific biography and assumes historical scientific importance. But the matter concerns not only and not even so much the history of the relativity theory. The definition of "Mach's principle" is linked with the historical interpretation of classical mechanics.

In each of his works on the general theory of relativity, Einstein criticized Newton's theory from the position of another theory which likewise proceeds from a pattern of masses moving in space and interacting on one another. Now Einstein approached the appraisal of Newton's mechanics from another, more radical position.

Further, Einstein pointed to other major defects of classical mechanics as a basis of physics from the view-point of "internal perfection" of mechanics. These include the existence of (1) the law of motion and (2) the expression for force or potential energy, each independent from one another. In classical mechanics, the law of motion is independent from the laws of the field. At the same time it is meaningless, unless the forces are predetermined. But the expression for force is chosen at random which is particularly aggravated by the requirement that the forces should depend on the position of the bodies, and not on their velocities. This requirement does not ensue in an unambiguous way from the principles of classical mechanics and is by no means self-evident. Conformity, unambiguous connection with the least number of initial principles, and the absence of any arbitrariness, all these criteria indicate that Newton's mechanics is devoid of inner simplicity and naturalness. Arbitrary for classical mechanics is also the potential function $1/r$ which determines the action of gravitational forces and forces of electrical attraction to and repulsion from a point mass or point charge which set up corresponding force fields. Einstein links this defect of classical mechanics with the idea of far action. The potential function $1/r$ in a central symmetrical solution of

differential equation $\Delta \rho = 0$, invariant with relation to rotation. The potential function is not arbitrary if it results from some law which points to its distribution in space. But such a law cannot be the initial principle of Newton's mechanics. It appeared as a description of real processes in a physical medium under the influence of facts and was directed against far action.

The above defects of classical mechanics, like the others specified further in Einstein's *Autobiography*, disturb its "internal perfection". Whereas for special theory of relativity another criterion ("external justification") was of primary importance, with the further expansion of the theory, its changeover to the general theory of relativity, the criterion of "internal perfection" *i.e.*, simplicity, naturalness and unambiguity, played a major euristic rôle.

The historian's important task is to clarify the real meaning of this criterion. By thoroughly examining it, we are able to note some analogy between Einstein's scientific method proper and his historical-scientific method as formulated in the *Autobiography*.

If one is to determine Einstein's scientific method proper, it may be called the method of invariants. The relativity theory meant a great triumph of the method, and the further development of this theory pointed very distinctly to the rôle of invariant analytical conceptions in its inner structure. Einstein strove to express the objective regularities of nature by means of magnitudes invariant as to co-ordinate transformations.

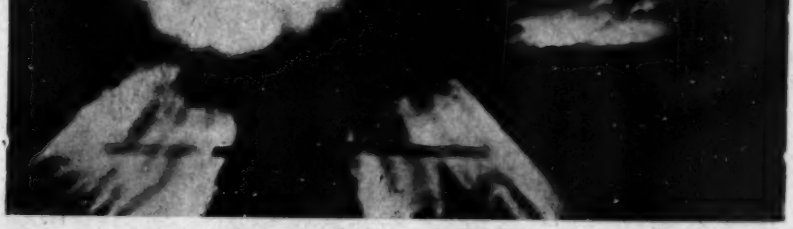
The same tendency, directed towards the past, underlies Einstein's historical-scientific method.

Simplicity of a theory is the criterion of its truth. What there does the word "simplicity" mean? It can be easily perceived that Einstein does not adhere at all to the old criteria of "simplicity" according to which nature functions. The case in point is that in its development the pattern of the world becomes devoid of anthropomorphous ideas and expresses the objective reality by increasingly objective methods independent, notably, from the methods of measurement, invariant as to the selection of methods of measurement and the "reference" systems. This, likewise, is what the condition of "naturalness" comes to, and, quite clearly this time, the condition of excluding arbitrariness in deriving conclusions from the initial premises.

It goes without saying that the above remarks about Einstein's historical method and the assessment of classical mechanics refer to but a small part of those numerous and profound historical-scientific ideas which the *Autobiography* contains together with the proper physical ideas.

MINIATURE SUN CREATED BY PLASMA "PINCH"

THE photograph taken in one ten-millionth of a second, shows a miniature sun created by a plasma "pinch".



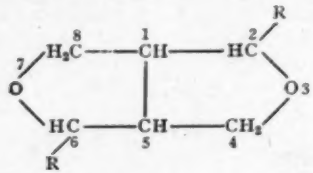
The plasma, a very hot deuterium gas whose atoms are stripped of their electrons is "pinched" inward toward the centre of the tube. As it is "pinched", it is also compressed and heated to several hundred thousand degrees—hotter than the surface of the sun—and glows brightly. The streaks of light are longitudinal views of the pinch reflected by mirrors.

Such photographs reveal plasma instabilities and eventually make possible a controlled fusion reactor.—(*General Atomic Division, General Dynamics Corporation.*)

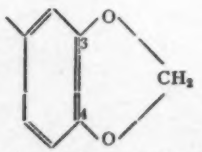
PROTON MAGNETIC RESONANCE IN SESAMIN AND ASARININS

G. GOVIL, C. R. KANEKAR AND C. L. KHETRAPAL
Tata Institute of Fundamental Research and Atomic Energy Establishment, Trombay, Bombay

SESAMIN and asarinin have attracted attention of biochemists in recent years particularly because of their antitubercular activity.[1,2] The structure of these compounds shown in formula I seems to have been fairly well established from synthetic evidence.[3]



where R is



(3, 4 methylene dioxyphenyl)

FIG. 1

Sesamin and asarinin are stereoisomers; in addition both the *d* and *l* forms of each of these compounds are known. It has been found that asarinin shows far more antitubercular activity than sesamin and further *d* sesamin and *l* asarinin are far more active than *l* sesamin and *d* asarinin respectively. According to Beroza[3] three configurations representing three different geometrical isomers are possible for compounds having formula I (Figs. 2-4). Of these only two (sesamin and asarinin) are known. Synthetic evidence[3] indicates that asarinin has structure IV while sesamin can be either II or III.

The proton magnetic resonance investigation of sesamin and asarinin was undertaken with a view to ascertain whether it can throw any further light on the structure of these compounds.

The spectra were recorded with the help of the Varian Associates' High Resolution Spectrometer. Earlier, attempts made to study these compounds at 30 Mc./s. gave somewhat inconclusive results because of the low intensity of

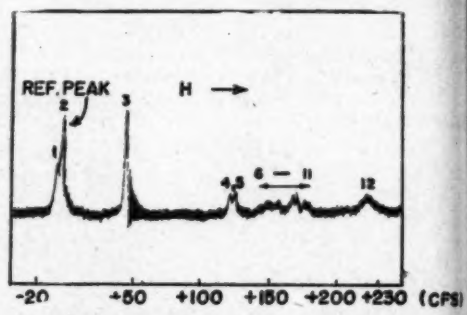


FIG. 5 (i). Spectrum of [*d*- sesamin][4] (frequencies are relative to ref. peak).

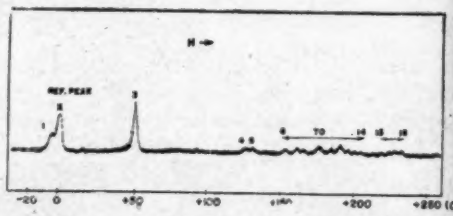


FIG. 5 (ii). Spectrum of *d*- asarinin (frequencies are relative to ref. peak).

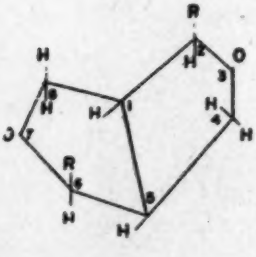


FIG. 2

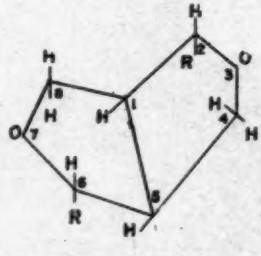


FIG. 3

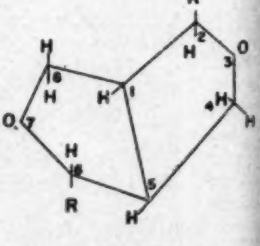


FIG. 4

the lines resulting from the relatively poor solubility of these compounds in a suitable solvent. Measurements were, therefore, finally made at an operating frequency of 60 Mc./s. where higher intensity and better resolution were obtained.

Solutions were made in CCl_4 through which nitrogen gas was passed for some time to remove any dissolved oxygen. The purity of the samples was checked by their melting-points and optical activity before they were sent to us. Due to the low solubility of these compounds a high R.F. (about 50 db. below 0·5 watts) had to be used with a relatively fast scanning rate to avoid saturation effects. The resolution attained was, therefore, of the order of 2 cps. The line shifts were measured for strong lines, relative to cyclohexane as an internal standard by the usual side band technique within an accuracy of 2 cps. The relative distances between the individual peaks of the spectrum of each compounds were however measured with greater accuracy (0·3 cps.).

The spectra of *d* sesamin and *d* asarinin are shown in Fig. 5. The values of the line shifts for individual lines in the spectrum have been tabulated (Table I) in terms of frequencies in cps. with reference to the second phenyl peak (marked reference peak). The chemical shifts for the various groups (expressed in parts per million relative to cyclohexane) are also given in Table I.

The spectrum of sesamin consists of 12 lines while that of asarinin shows more lines (at least 18 in number). An inspection of structures II, III and IV, shows that structure IV has more non-equivalent protons. More lines are therefore expected for structure IV than either II or III; the last two structures are expected to give the same number of lines. The spectrum, therefore, enables us to conclude that asarinin has an unsymmetrical structure IV with more non-equivalent protons in agreement with the synthetic evidence.

The peaks No. 1 and 2 in each spectrum are assigned to the phenyl protons in the side chain R. There are six such protons in each molecule. The values of the chemical shifts for these two lines are within the range observed for phenyl protons (− 4·8 to − 6·3 p.p.m. *c.f.* Meyer, Saika and Gutowsky[4]). There are also four protons of the dioxymethylene group in the side chain. Owing to the proximity of two oxygen atoms of the dioxymethylene group, one expects a shift to much lower fields for these protons as compared to the protons in CH and CH_2 in the main rings. Also the intensity of line due to these protons should be 2/3 of that of the phenyl protons. These considerations indicate that line 3 arises from the resonance of dioxymethylene protons. The remaining lines arise from the protons attached to the fused furan rings.

Because of the several types of spin couplings the spectrum of sesamin and asarinin is expected to be quite complicated. A complete analysis of all the lines has not, therefore, been attempted. It is, however, possible to ascertain the ranges of the chemical shifts for various non-equivalent groups and to identify the different structures II, III and IV from one another. From the measurements made at another operating frequency (*e.g.*, 30 Mc./s.), it is further possible to distinguish between chemical shifts and coupling constants.

A model of these molecules made in the laboratory indicates that the two tetrahydrofuran rings are themselves planar but are fused to each other in such a way as to give a chair-type molecule. In such a configuration the protons are either in the cis- or trans-position with respect to one another. Since the HCH angles in such a fused ring are not expected to be much different from those in a 6-membered ring, one expects that the coupling constants for sesamin and asarinin should be of the same order of magnitude as in substituted cyclohexanes. The coupling between the cis-position in such a chair-type configuration will be analogous to the equatorial coupling in substituted cyclohexane (~3 cps.) while the coupling between the protons in trans-position will be analogous to the axial-axial coupling (~7 cps.).[5]

In sesamin which can be either II or III, the protons can be divided into 3 non-equivalent groups (*a*) those in position 2 and 6 (*b*) those in 4 and 8 and (*c*) those in position 1 and 5. The (*a*) group protons are expected to exhibit resonance at the lowest field because of their linkages with oxygen atoms and phenyl groups; the (*c*) group protons are likely to resonate at the highest field as they are β to oxygen atoms; and the (*b*) group resonance should occur in between. On these considerations lines 4 and 5 have been ascribed to (*a*) group, the broad peak occurring at highest field appears to be due to (*c*) group while those between 6 and 11 are due to the (*b*) group split up by various coupling constants. The chemical shift of (*b*) group protons agrees with the chemical shift of α protons in tetrahydrofuran (− 2·2 p.p.m. relative to cyclohexane observed in our laboratories). The multiplet structure due to spin coupling does not seem to have been resolved for (*c*) group. In

structure II, the (*a*) group protons are placed cis with respect to the (*c*) group. This should result in a doublet due to (*a*) group separated by about 3 cps. On the other hand, for structure III this doublet separation should be of the order of 7 cps. The lines 4 and 5 show a separation of 3·9 cps., at both the operating frequencies. This therefore suggests that sesamin has structure II. It would be interesting to obtain n.m.r. of compound of structure III if such a compound could ever be synthesised and to test the prediction of a relatively large coupling constant for the protons in 2 and 6.

In asarinin (structure IV) the protons in 2 and 6 positions are placed unsymmetrically with respect to each other. The proton in 2 position is coupled to proton in 1 position much in the same manner (cis) as in sesamin. The coupling between them is, therefore, expected to be of the order of 3·9 cps. The other protons in trans-positions 5 and 6 will experience a much larger coupling (~ 7 cps.). One would, therefore, expect a quartet in the spectrum for these two protons. Actually a doublet has been observed for this group (lines 4, 5) with a separation of 5·6 cps. at both the operating frequencies. Since the chemical shift between the proton in 2 and 6 positions seems to be negligible, we believe that the doublet is due to the overlapping of the four lines which could not be resolved as our resolution is of the order of only 2 cps. The remaining spectrum of asarinin arises on account of several coupling constants referred to above and the non-equivalence of many of the protons attached to the fused rings. No attempts have been made to analyse this part of the spectrum but the average values of the chemical shifts for the groups —CH and —CH_2 attached to the rings have been reported in Table I. These values are in agreement with the corresponding values for sesamin and are in the range expected for these groups.

TABLE I

Spectra of d-*sesamin and asarinins*

Group of protons	*d*-sesamin			*d*-asarinin			*l*-asarinin	
	Peak No.	Frequency separation (cps.) referred to 2nd phenyl peak	Shift in p.p.m. relative to cyclohexane	Peak No.	Frequency separation (cps.) referred to 2nd phenyl peak	Shift in p.p.m. relative to cyclohexane	Frequency separation (cps.) referred to 2nd phenyl peak	Shift in p.p.m. relative to cyclohexane
Phenyl ..	1	− 3·8	−5·31 to	1	− 4·7	−5·35 to	− 4·4	−5·33 to
	2	0	−5·25	2	0	−5·27	0	−5·26
Dioxymethylene ..	3	46·6	− 4·47	3	46·4	−4·50	47·6	−4·47
C–H *a* to phenyl ..	4	122·7	−3·20 to	4	114·6	−3·36 to	116·1	−3·32 to
and >O group	5	126·6	−3·13	5	120·3	−3·26	121·7	−3·23
–CH_2 *a* to >O but	6	145·2	..	6	139·8	..	141·3	..
not in *a* position	7	153·3	..	7	146·5	..	148·1	..
to phenyl group	8	160·0	−2·82 to	8	151·3	..	152·6	..
			−2·22	9	162·8	..	162·3	..
	9	168·6	..	10	169·8	−2·94 to	167·2	−2·90 to
				11	175·7	−2·10	175·6	−2·10
	10	173·4	..	12	181·8	..	181·2	..
				13	185·3	..	185·6	..
	11	181·3	..	14	189·8	..	189·8	..
			..	15	214·3	..	213·5	..
			..	16	219·8	−1·69 to	219·3	−1·70 to
C–H β to >O ..	12	223·5 (Broad line)	−1·50	17	225·1	−1·43	224·1	−1·43
				18	230·1	..	229·6	..

The spectrum of *d* and *l* forms of asarinin are identical (within the experimental error of this investigation) and it does not seem possible to distinguish between the two optical isomers by the n.m.r. method.

The authors wish to thank Dr. A. S. Ramaswamy of the Indian Institute of Science, Bangalore, for having initiated them into this problem by kindly supplying pure samples of the isomers and Shri. S. C. Mathur for his initial help. The authors are also grateful to Professor S. S. Dharmatti for his encouragement and general guidance in this investigation.

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THE CARNEGIE INSTITUTION*

THE Year-Book No. 59 of the Carnegie Institution of Washington is again a highly informative scientific publication of current interest. It records the progress of work and the new achievements of the seven departments of the Institution for the year July 1, 1959 to June 30, 1960. Researches of a basic nature which will extend the frontiers of knowledge have always been the primary concern of the Institution. In this objective the different Departments work in co-ordination, and the subjects of study range from the tiniest particles of life on this planet to the outermost galaxies detectable in space. Life sciences play a major role in the Institution's activities. In these studies as many as five departments take part and results of significance obtained during the year have been included in the Year-Book.

Astronomical discoveries are always exciting and are taken for granted without much questioning. The Mount Wilson and Palamor Observatories have reported some spectacular observations during the year. Dr. Rudolph Minkowski (whose retirement after a long stretch of meritorious association with the Institution has been announced) photographed through the 200-inch Hale telescope the most distant astronomical object thus far discovered. It is a cluster of galaxies apparently receding from the earth at the rate of 138,000 km./sec., almost half the speed of light. It may be noted that this cluster was first located by radio astronomy methods, first at the Cavendish laboratory, England, and later at the California Institute of Technology. Accurate location by radio-receivers made possible the remarkable spectral photographs obtained by Minkowski.

During the year not only the farthest astronomical object has been photographed but the oldest cluster has been found. This is NGC 188, whose age according to Sandage of Mount Wilson is 25 billion years. The farthest and the oldest are not the only ones to go into record. A star with the strongest magnetic field so far has been found by H. W. Babcock. It is the A-type star HD 215441 whose spectrogram with the 200-inch reflector revealed Zeeman splitting corresponding to a magnetic field of 34,400 gauss (*cf.* sunspot magnetic fields of 4,000 gauss). There is no doubt that these extremes supply crucial tests for cosmological theories.

One of the major programmes in which the Geophysical laboratory, jointly with the Department of Terrestrial Magnetism, has been actively engaged in recent years is the charting of the phase equilibria of important mineral systems. The primary methods for these investigations lie in the use of high-pressure, high-temperature equipment for synthesizing and metamorphosing minerals in the laboratory. During the year Boyd and England succeeded in synthesizing diamond from graphite. The synthesized product resembled natural carbonado diamonds used for industrial purposes, and were obtained at 75,000 atmosphere and 1,500° C., in grain sizes of as much as 0·1 mm. Progress on the work with olivines has yielded some significant results. A dense spinel form of the iron olivine fayalite was obtained under pressures of 60-80 kilobars, and it was found that the transition from fayalite to spinel occurred in about the same pressure—temperature range as the inversion from graphite to diamond. These results are significant in the sense that the fayalite-spinel transition may explain the marked seismic discontinuity known to exist at a depth of about 400 km. in the earth's mantle.

In the Department of Terrestrial magnetism the investigations of the "equatorial electrojet" in the upper atmosphere above Peru which formed part of the IGY programme was completed during the year. The 60-ft. parabolic reflector whose completion has been announced is expected to be used for major contributions in the observing programme of the Department. In the Department's activities devoted to biophysics the results obtained on the dynamics of the syntheses of proteins and nucleic acids by intact living cells are fresh and striking.

The Department of Plant Biology has been chiefly concerned for several years with the study of different forms of chlorophyll that occur in living plants. The primary question around which much of the year's work has centred is whether or not the different forms of chlorophyll *a* all participate in photosynthesis, and, if so, in what manner. It was found that at least two of the forms of chlorophyll *a* function differently. The two pigment mechanism is an essential part of photosynthesis. Experiments during the year lead to the conclusion that the photophosphorylation reaction and the formation of reducing power, two well-known parts of the

* *Carnegie Institution of Washington Year-Book No. 59* (The Director of Publications, Carnegie Institution of Washington, 1530, P. Street, North-West, Washington. 5, D.C.), 1960. Pp. lvii+515, Price: Paper bound $ 1·00; Cloth bound; $ 1·50.

photosynthetic process, are driven by separate pigments.

Dr. M. Demerec, Director of the Department of Genetics, retired from the Institution on June 30, 1960. He joined the Institution in 1923, and throughout his lifelong association with it his researches have been directed towards elucidating the structure, the function, and the mutability of genes. Further studies in this field during the year carried out with *Salmonella typhimurium* and hybrids obtained by crossing *S. typhimurium* with *Escherichia coli* have been reported.

A notable achievement in the Department of Embryology during the year is the successful visualisation of circulation in the maternal placenta by the techniques of radioangiography. The experiments were conducted on pregnant Rhesus monkeys. The technique lies in injecting into the femoral artery 15 ml. of radiopaque dye under 90 pounds pressure (the high injection pressure is an essential part of the technique), and following the course of the dye through the various arteries, and finally through the intervillous space of the placenta. The visual displaying of the circulation uses a combination of image intensifier and television system.

It is needless to mention that the Year-Books of the Carnegie Institution, Washington, containing the latest progress in the different fields of fundamental investigations undertaken by the Institution, are valuable additions to current scientific literature.

PLANNED FOREST DEVELOPMENT FOR INDIA

DR. J. A. VON MONROY, the FAO expert on forest industries, held recently an assignment in India to help design an overall plan for the integrated development of India's forests and forest industries. According to him forest resources in India, as they stand now, are not enough to meet the requirements of the country's present population of 420 million, let alone the estimated population of 600 million for 1975. India is famous for the production of valuable *slow-growing timbers*. However, present conditions demand a vast increase in the supply of wood, which can only be met by planting *fast-growing species*. Dr. von Monroy's proposal is to select about 1% of India's forest area, in the most productive parts of the country, and to plant 150,000 acres per year over the next ten years with trees which mature within 15 years. This development, coupled with intensive management arrived at raising the forest yield per acre, should double the present production of industrial wood. Dr. von Monroy's other recommendations include the development of the Himalayan coniferous forests, expanded use of low grade timber, and the use of building boards instead of solid timber.

The second phase of the programme is about the forest industries. It is estimated that for paper alone the demand will jump from the present 450,000 tons to 2·1 million tons by 1975. This can only be met by a dramatic increase in the number of pulp and paper mills, as well as fibreboard and wood particle board plants, coupled with increased use of hardwoods and adoption of modern processing techniques, such as the high-yield system. A pre-investment survey must be carried out now to determine exactly where these industries shall be located.

It is also expected that fuelwood requirements, mostly for cooking, will jump to the astounding peak of 100 million tons by 1975. A large fuelwood plantation programme has been planned, but this must be supplemented by making better use of supplies, such as popularizing more efficient simple kitchen stoves through community development projects. A very important item in India is the supply of minor forest products, such as tanning material, resin, medicinal plants and oils. Much of this demand can be met by creating small-scale cottage industries, which will, of course, greatly help rural development.—(*FAO News.*)

A CORRECTION

OUR attention has been drawn to the following statement which appeared in *Current Science*, 1956, Vol. 25, p. 283. "Dr. Ramdas began his career as a Palit Research Scholar from 1923-26 under Sir C. V. Raman and discovered the phenomenon of the 'Scattering of Light by Pure Liquid and Sound Surface'." On a reference to the original publications of the time, we find that the statement should have read: Dr. Ramdas began his career as a Palit Research Scholar from 1923-26 under Sir C. V. Raman and collaborated with Professor Raman in his fundamental researches on the scattering of light by liquid and solid surfaces. We regret the publication of the earlier erroneous report.

LETTERS TO THE EDITOR

THE USE OF THE THREE-ELECTRODE TRIGGER IN THE SPECTRAL STUDY OF EXPLODING WIRES

THE circuit which is usually employed for exploding a short metal wire W, having a resistance of a few milliohms, by the discharge of a condenser C charged to a high voltage is shown in Fig. 1.[1] The spark gap G has been replaced

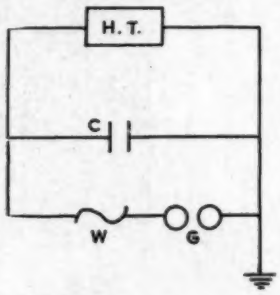

FIG. 1

by various types of triggering devices in order to reduce the energy losses in the spark gap G and to make the discharge more instantaneous.[2] One such simple device is the three-electrode trigger shown in Fig. 2.[3]

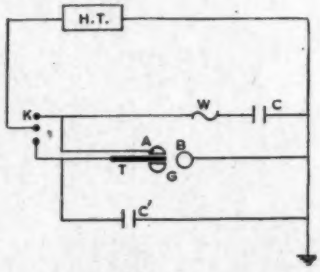

FIG. 2

By connecting the special key K to both the condensers C and C' they are charged simultaneously from the same H.T. to a voltage slightly less than the breakdown voltage V for the gap G between T and B. This prevents any large potential difference between T and A. The key is then connected to C alone and C is charged to the voltage V. C is then disconnected and K connected to C' alone, charging it to the same voltage V when the gap G between T and B breaks down, providing a path for the breakdown of the gap between A and B in series with the main condenser C and the wire W.

In this arrangement, thus, the gap G is shorted by the triggering spark between T and B, the energy for this being supplied by the triggering condenser C'. The present investigation concerns with the change, if any, in the spectral nature of the explosion of the wire in the two cases. The gap width G in Fig. 2 could be adjusted so that breakdown occurs at any desired value of the voltage. Copper wires 1·5" in length and of different diameters are used. The spectrum is recorded in one explosion at atmospheric pressure using a Hilger medium quartz spectrograph. The main condenser C has a capacity of 176 μF. and the triggering condenser C' 0·75 μF. The voltages used are in the range 2·5 to 5·5 KV. The spectrum is first photographed using the arrangement in Fig. 2 when the spark gap G is shorted by the condenser C'. T is then disconnected from C' and connected to the bob A which then gives us an arrangement similar to that in Fig. 1 and the spectrum of the explosion is again photographed, keeping all other parameters the same as in the previous case. The spark gap G is now shorted by the main condenser C itself. It is found that the spectrum of the exploding wire remains unaltered in nature and intensity in both the above cases. Also the overall intensity of the explosion in the two cases, as measured by a photoelectric cell kept at a fixed distance from the wire, remains the same.

According to Chace,[4] the discharge of the condenser through the wire takes place in two phases: (*a*) the vaporisation of the wire with explosive violence or transplosion, in which part of the energy stored in the condenser is used and (*b*) reignition, *i.e.*, the restrike of the discharge through the metal vapour in which the rest of the energy stored in the condenser is spent. The energy spent in the first phase includes the energy used in breaking the gap G. On the basis of this theory, the present results could be explained if we assume that (*a*) the spectral intensity of the explosion is due to the second phase and (*b*) the energy spent in the first phase is negligible compared to that spent in the second phase, so that the latter is not affected whether the gap G is shorted at the expense of the energy from the main

condenser C or not. It is, therefore, not necessary to use any involved mechanism to trigger the gap G if one is concerned with the spectral study of the explosion.

Physics Department, University of Delhi, Delhi, *April* 20, 1961.

K. GOPALA KRISHNAN.
JUGAL KISHORE.
K. RAJAGOPALAN.*

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* Council of Scientific and Industrial Research, New Delhi.

ANION UPTAKE OF A CATION EXCHANGE RESIN

IT is well known that the selectivity of an ion exchange resin is governed by the concentration of the external electrolyte solution. In equilibrium with dilute solutions, the resin is very selective. But the selectivity falls off as the concentration of the external solution is increased due to increased uptake of anion in case of a cation exchange resin and of cation in case of an anion exchange resin.

It is reported[1,2] that in case of cation exchange resins, the Donnan uptake, as for example of chloride ion, is controlled by the type of cation present. The quantity of chloride uptake is determined by the crystallographic radius of the cation, its valence and charge, the uptake increasing with increase in radius as well as valence and charge. No data seem to exist indicating the type of variation observed in case of absorption of different anions by the same metal form of a cation exchange resin.

In this note, data have been presented for the crosslinked sodium form phenol sulphonate resin rods in equilibrium with four different anions (Cl^-, Br^-, CO_3^{2-} and $Citrate^{3-}$) in the concentration range 0·001 N to saturation at 30° C. The results relating to anion uptake expressed as a normality ratio (N, internal/N, external) and density (g.ml.$^{-1}$) are presented in Figs. 1 and 2 respectively.

The anion absorption cannot be related to any of the characteristic parameters of the ions like their radius, valence or charge. However the following points are of interest.

1. In the concentration range 0·001 to 0·01 N the resin is highly selective and excludes anions almost completely. As the concentration is increased to 0·1 N, it picks up some anions, in any one case the concentration not exceeding about 0·02 N.

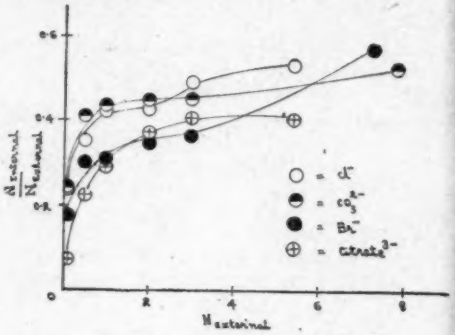

FIG. 1

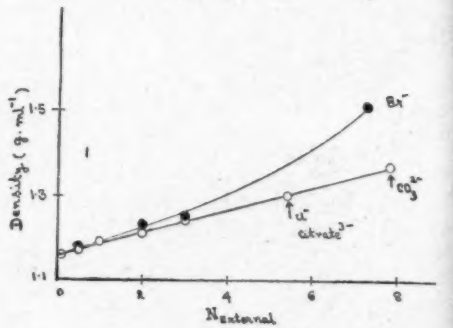

FIG. 2

2. In the range 0·1 to about 1·5 N, the order of anion absorption is as

   $CO_3^{2-} > Cl^- > Br^- > Citrate^{3-}$

   At about 1·5 N, the Br^- uptake becomes less than that of $Citrate^{3-}$ and at nearly 4 N, it begins to rise continuously. Up to an external concentration of about 2·5 N, the order of anion absorption is roughly in keeping with the decreasing order of their equivalent weights.
3. At 2·5 N, Cl^- uptake rises above that of CO_3^{2-} and in the concentration range above 2·5 N, the order of uptake is as

   $Cl^- > CO_3^{2-} > Citrate^{3-}$

   with the Br^- absorption rising through the series.

The density data of Fig. 2 indicate that the resin absorbing CO_3^{2-}, Cl^- and $Citrate^{3-}$ severally has the same density values which rise gradually as the external concentration is increased. This is so, within the limits of experimental error,

due to the quantity of anion uptake being in the reverse order of their equivalent weights. As Br^- has the highest equivalent weight and roughly the same amount of absorption by the resin as the $Citrate^{3-}$ up to about 4 N, the density values are higher.

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DI-IODO TETRACARBONYL IRON II

Some physical measurements like infra-red absorption, magnetic susceptibility, etc., have been made with di-iodo tetracarbonyl iron II complex and are reported here. Solution of iodine in petroleum ether (60°–80° C.) was added to a solution of iron pentacarbonyl, $Fe(CO)_5$, in the same solvent in an inert atmosphere. Some modifications were made to the earlier method.[1] Nearly 3 g. of pure and dry compound, $Fe(CO)_4I_2$, was prepared.

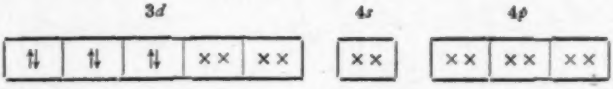
The complex is virtually a non-electrolyte in nitrobenzene, Λ_M in $1{\cdot}04 \times 10^{-3}$ M solution being 1·2 mho. at 25° C. In powder form, the compound is diamagnetic, χ_g being $-0{\cdot}15 \times 10^{-6}$ at 21° C. The molecular weight determinations in benzene show that it is monomeric. The infra-red absorption spectrum of the compound in Nujol suspension shows three sharp peaks at 2137 $cm.^{-1}$, 2088 $cm.^{-1}$, 2070 $cm.^{-1}$

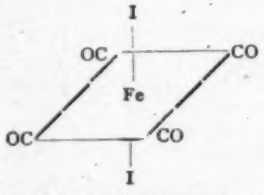
The compound is monomeric and diamagnetic indicating that it is clearly an octahedral spin-paired complex of iron II. Bivalent iron has an effective $3d^6$ configuration and hence a $3d^2 4s\ 4p^3$ hybridisation is involved in the formation of this compound giving an octahedral distribution of the ligands.

Infra-red absorption measurements on this compound can further distinguish between the following two structures: (1) trans di-iodo structure and (2) cis di-iodo structure.

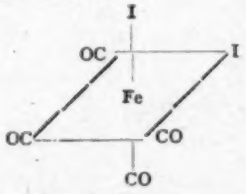
If the compound has structure 1, only one peak is to be expected in the carbonyl region due to an overall symmetry of the molecule. For structure 2, more than one and up to four peaks can be observed if there is no overlapping. In fact, three sharp peaks have been observed. This appears to be a strong evidence for assigning a cis di-iodo structure to the compound. This assignment is also in agreement with the dipole moment measurements of Weiss[2] who found a finite value of 3·6 D; the trans di-iodo structure is expected to have a zero dipole moment.

Thanks are due to Prof. R. S. Nyholm, F.R.S., University College, London, W.C. 1, for his help and advice in the work.





1. trans di-iodo structure



2. cis di-iodo structure

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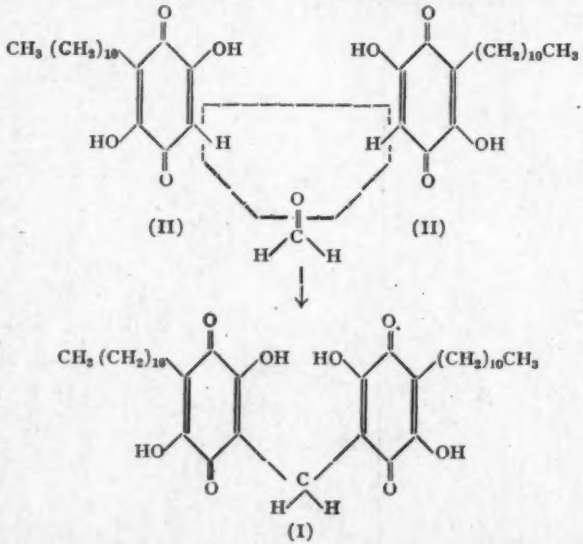
VILANGIN—A NEW CONSTITUENT OF *EMBELIA RIBES* AND *E. ROBUSTA*

Modified extraction of the powdered dry berries of *Embelia ribes*[1] using purified methanol or dioxan yielded a new constituent, bright orange yellow in colour, m.p. 264-65° C. decomp. It is designated by us as "Vilangin," a name taken from the vernacular Telugu name, *Vayuvillanga* for *Embelia ribes*. Its molecular formula analysed to $C_{35}H_{52}O_3$, confirmed by Rast molecular weight of 610. It contained no alkoxyl groups and no oxide linkages. It is acidic in character and gave an intense brown ferric colour. Vilangin formed a yellow tetramethyl

ether and a pale yellow tetra-0-benzoyl derivative, indicative of four phenolic hydroxyl groups. It contained no alcoholic hydroxyl groups. On heating with *ortho*-phosphoric acid, anhydrovilangin was obtained, indicative of two hydroxyl groups which could be dehydrated readily. Vilangin could be regenerated by hydrolysis of anhydrovilangin using dilute potassium hydroxide. On acetylation by the acetic anhydride-pyridine method, two acetates were obtained: (1) an orange yellow tetra-0-acetylvilangin (which regenerated vilangin on hydrolysis) and (2) a red di-0-acetylanhydrovilangin, identical with the acetate obtained from anhydrovilangin. Reductive acetylation of vilangin gave two leucoacetates: (1) an octa-0-acetyl-tetrahydrovilangin (from which vilangin could be recovered by hydrolysis and subsequent aerial oxidation) and (2) a hexa-0-acetyl-tetrahydroanhydrovilangin identical with the reductive acetylation product of anhydrovilangin. These reactions indicated the existence of two quinone units which could easily be reduced and reoxidised. This is further supported by the formation of a tetroxime, a tetra-2 : 4-dinitrophenylhydrazone, a tetra-anil and a tetra-desoxy-tetramethylimino compounds. Further, oxidation of vilangin using alkaline permanganate gave *n*-lauric acid, whilst alkali fission gave α-ketomyristic acid, which are also products of similar reactions from embelin. These observations were further supported by the isolation of embelin by pyrolysis of vilangin.

From these considerations, vilangin is assigned the structure, methylene-bis (2 : 5-dihydroxy-4-undecyl-3 : 6-benzoquinone) (I). This constitution of vilangin was further confirmed by an unambiguous synthesis using embelin (II) and its ready condensation with formaldehyde in neutral, acidic or alkaline solutions. Although other dibenzoquinones are known, *e.g.*, oosperein and phoenicin,[2] vilangin seems to be the first known example of a methylene-bis-benzoquinone occurring in nature.

Vilangin was found to occur in the dry berries of *Embelia robusta* also. Fuller details will be published elsewhere.



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RAPID DETERMINATION OF MOISTURE CONTENT OF PARBOILED RICE BY AN IMMERSION METHOD

It was reported in an earlier communication that the bulk density of parboiled rice rose from 0·75 to 0·80 during drying while moisture decreased from 20 to 11%.[1] A method of relating the specific gravity of the rice grains as determined by an immersion method to its moisture content is described here.

Solvents of densities varying from 1·42 to 1·48 were prepared using mixtures of distilled kerosene (boiling between 170–200° C.) and chloroform. Both the solvents were saturated with water to eliminate the effect of the varying moisture content of the rice samples. Details of the composition of mixtures of varying specific gravity as determined with a specific gravity bottle at 28° C. are given in Table I. When pre-

TABLE I

Mixtures of chloroform and kerosene of different densities

	Temperature 28° C.						
Kerosene added to 20 c.c. of chloroform (ml.)	1·50	1·25	1·00	0·75	0·50	0·25	0·00
Specific gravity of the mixture	1·42	1·43	1·44	1·45	1·46	1·47	1·48

served in glass-stoppered bottles at room temperature (25°–30° C.) even over a period of 30 days, these solvent mixtures did not show variations in the density. About 50 grains of the test sample of rice were added to small beakers containing these solvent mixtures. The specific gravity of the mixture in which the majority of the grains (90–95%) just sank was taken as representing the density of the grains. It was found that the grains in any sample exhibited the same density and behaved in the same manner. Only very few grains were lighter or heavier than the others.

The pattern of results obtained by testing five different commercial samples of 'Ratnachudi' variety and two samples of 'Kar' variety rice at various moisture levels ranging from 19·5 to 10·5% are presented in Table II. The moisture content of the rice samples was determined by drying at 105° C. for 18 hours in an electric oven.

Results presented in Table II indicate that these solvent mixtures could be used with fair certainty to determine rapidly by the simple immersion method the moisture content of rice samples within a range of 1·5%, and could be employed as a quick test when automatic moisture meters are not available.

TABLE II

Floating or sinking properties of rice samples in solvents of different densities

Moisture range %	Density of solvent mixture						
	1·48	1·47	1·46	1·45	1·44	1·43	1·42
19·5–18·0	F	F	F	F	F	F	S
17·9–16·5	F	F	F	F	F	F*	S
16·4–15·0	F	F	F	F	F	S	S
14·9–13·5	F	F	F	F	S	S	S
13·4–12·0	F	F	F	S	S	S	S
11·9–10·5	F	F	S	S	S	S	S

F— All 7 samples float ; S— All 7 samples sink ; * 2 out of 7 samples sank in this mixture.

Parboiled rice of commerce has generally too high a moisture content for safe storage. Maximum permissible limits for moisture are now being contemplated and in enforcing these standards rapid methods of determining moisture content in rice are necessary, and a rapid test could be made by using the solvent mixture which gives the specific gravity of 1·45. If the commercial sample sinks in this mixture then the moisture content of the sample is lower than 13·5% which is a safe limit.

C.F.T.R.I., Mysore, *May* 1961.

R. RADHAKRISHNAMURTY.
H. S. R. DESIKACHAR.
V. SUBRAHMANYAN.

FERTILIZER VALUE OF DICALCIUM PHOSPHATE

DICALCIUM phosphate, prepared by treatment of rock phosphate with hydrochloric acid, offers a considerable scope of being used as a substitute for superphosphate, manufacture of which involves the use of sulphuric acid. The material has been used as a phosphate fertilizer by many workers and the general trend of the results show that it is very often as good as superphosphate. Field experiments carried out by present authors confirm the previous findings as the following results will show.

TABLE I

Yield of wheat and maize in Delhi Soil

(In mds./acre, average of six replications)

Treatment	Wheat (N.P.710)		Maize (Yellow 2)	
	(1957–58)	(1958–59)	(1958)	(1959)
No Manure ..	8·92	9·64	4·08	9·32
40 lb. N/acre ..	14·09	15·71	7·58	17·75
40 lb. + 80 lb. P_2O_5 as superphosphate/acre	19·28	21·27	9·18	15·78
40 lb. + 80 lb. P_2O_5 as dicalcium phosphate/acre	18·28	16·99	8·47	12·97
C.D. at 5% ..	2·69	9·09	0·88	5·07

The results indicate that P_2O_5 when applied either in the form of monocalcium phosphate or dicalcium phosphate is equally suitable on the neutral and alkaline soils.

Indian Agri. Research Institute, New Delhi, *March* 21, 1961. A. K. RISHI. V. ISWARAN.

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DISCOVERY OF MARINE, PERMO-CARBONIFEROUS IN THE WESTERN RAJASTHAN

WHILE carrying out mapping of the pre-Jurassic sediments in the western Rajasthan peneplain this year, the authors encountered richly fossiliferous sediments of Permo-Carboniferous age. The occurrence of it is being reported for the first time. The fauna yielded by these sediments indicates a marine environment of deposition.

Exposed near the village *Badhaura* (27° 18' : 72° 17') in the Jodhpur District, this formation has been provisionally designated as the *"Badhaura Formation"*.

It is coincidental that many earlier workers[1-4] have reported certain 'Permo-Carboniferous glacial deposits'—the so-called 'Bap-Beds'—from around the same area. It should be, nevertheless, noted that these earlier reports refer, exclusively, to the terrestrial deposits, their age being fixed on the basis of the lithological and environmental similarity to the 'Boulder Beds' of Talchir, 'Boulder Beds' of Salt Range, etc., unsupported by fossil evidence. The Bap Boulders, consisting of a wide assortment of boulders of various sizes and different rock types, both igneous and metamorphic, bear some grooves which are suspiciously similar to the effects of glacial transportation.

The general stratigraphy of the area, showing the position of the *Badhaura Formation* therein, is given in Table I.

Bap Boulders, referred to earlier, and the "bouldery" yellow sandstone/grits of the Badhaura Formation are, in our opinion, broadly contemporaneous; the former representing glacial drift near the shore and the sporadic boulders in the sandstones/grits of the latter, being probably ice-rafted.

The fauna collected from the Badhaura Formation consists of :—

(1) *Products* sp.; (2) *Spirifer* sp.; (3) *Spiriferina* sp.; (4) *Derbyia* sp.; (5) *Lingular* sp.; (6) *Straparollus* sp.

There are many other gastropods, lamellibranchs, cephalopods and plant stems; the detailed identification of the entire fauna and flora is in progress.

The Badhaura Formation probably represents the eroded remnants (mostly overlapped by the later Mesozoic deposits—'Mayakor Formation')

TABLE I

Mayakor Formation	10 m.	Brown to black, compact, ferrugenous and yellow friable sandstone with fossil wood	Equivalent to the *Lathi Formation* (Mid-Jurassic)
		UNCONFORMITY	
Badhaura Formation	20 m. *plus*	Yellow sandstone and reddish brown clays with hard band of brown ferrugenous sandstone containing lamellibranchs and petrified plant stems, with a highly calcareous sandstone at the base studded with casts of brachiopods	
		Yellow, compact bouldery sandstone and grits inter-bedded with dark brown, concretionary sandstone containing brachiopods, lamellibranchs, gastropods, cephalopods and fossil wood. These sandstones and grits are bouldery, containing pebbles and boulders of granite and other igneous and metamorphic rocks	Permo-Carboniferous
		Dark grey and yellow clays with pebbles and boulders of granite and other igneous rocks	
		UNCONFORMITY	
Phalodi Limestone	90 m.	Light to dark grey, cherty dolomitic limestones, dolomites and chert beds	
		UNCONFORMITY	
Phalodi Sandstone	150 m.	Red, fine to medium grained, illsorted, highly current bedded and friable sandstone with minor clays and bands of gypsum	Palæozoic (?)
		UNCONFORMITY	
Crystalline Basement	..	Granites and Rhyolites	Malani-Suite (?)

of the sediments deposited in a vast Palæozoic basin, which could reasonably be thought of as the eastward continuation of the arcuate (convex to south) Persian Gulf Basin.

It is concluded that the Mesozoic and younger sediments of Western Rajasthan are probably underlain by an appreciable thickness of Palæozoic sediments, thereby, enhancing the hydrocarbon prospects of the area.

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ABOUT FLUID INCLUSIONS IN BARITE FROM PULIVENDLA

WITH the object of finding the temperature of formation of barite deposit and the nature of ore-forming fluid, numerous fluid inclusions in barite were examined and their temperature of homogenisation was measured by the method developed by Ermakov (1950).

Barite occurs as fissure veins and replacement veins (Coulson, 1933) in the Vempalle limestone and associated trap (diabase) sills of the Papaghni Series, in the Cuddapah System. Numerous shear fractures and dislocation planes are usually found at the contact of Vempalle limestone with the trap sills. The best quality of barite occurs between two trap sills, often in large quantities (Krishnan, 1953). At places barite is associated with very thin veins and stringers consisting of pyrite, chalcopyrite, magnetite and malachite. In such places barite invariably acquires pink, green and grey colours.

The microscopic examination of thin plates of barite shows numerous fluid inclusions. They have various shapes—tube-like, mostly oriented along (011), and ellipsoidal, crudely oriented along (110) of the crystals. In addition, there are large numbers of irregular-shaped inclusions arranged along the boundaries of crystals. Apart from these primary inclusions, many irregular inclusions are arranged along the parting planes and other fine fractures. These are secondary inclusions.

The fluid inclusions in barite are mostly one phased (liquid only), rarely two phased (liquid + gas) and occasionally three phased (water + liquid CO_2 + gas). In most of these, gas occupies about 10% of the volume of inclusion but liquid CO_2 at 18° C. occupies about 20% of the volume of inclusion. The primary inclusions contain all the three types but the secondary ones are invariably one phased (liquid) only.

The temperature of homogenisation in primary inclusions (57 determinations) range from 125° to 130° C. but the secondary inclusions have the temperature of homogenisation as 65° to 50° C.

A qualitative microchemical analysis of the water extract of fluid inclusions from pink barite indicated the presence of the anions Cl', $HCO^{3'}$, SO_4'' and the cations Ca'', Mg'', Fe'', Na'. The water extract was distinctly alkaline having pH = 8 at 20° C.

The temperature of homogenisation of inclusions of ore-forming fluid indicates that barite was formed in a low temperature hydrothermal phase where the temperature was of the order of 130° C. It is probable that the trap introduced much of the barite in solution (Krishnan, 1953). The chemical analysis of fluid inclusions indicates the following possible combination of easily soluble salts which can be present in water solution in the fluid inclusions: chlorides—NaCl, $CaCl_2$, $MgCl_2$, $FeCl_2$; bicarbonates—$Ca(HCO_3)_2$; sulphates—$CaSO_4$, $MgSO_4$; probably the chlorides have played an important role in the formation of barite. It is established that the solubility of barite in water is greatly increased in the presence of NaCl. However, the chemical environment during the formation of barite can only be judged by investigating the fluid inclusions in the associated minerals like quartz, calcite and malachite, etc.

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A MODIFIED MEDIUM FOR THE PRODUCTION OF PERTUSSIS VACCINE

SEVERAL media both solid and liquid are used for the production of pertussis vaccine. A simple solid medium useful for mass production of vaccine is described below.

To casein hydrolysate (Sokhey *et al.*, 1950) were added 2·5% agar powder, 0·5% activated charcoal (Nuchar) and steamed for 15 minutes. The medium was then distributed in Roux

bottles and sterilised at 115° C. (10 lb./sq. inch) for 15 minutes. The bottles were taken out of the steriliser, cooled to about 60°–70° C. and 10·0% sterile yeast dialysate containing 5 units per c.c. crystalline penicillin G. sodium were added, mixed well and sloped. The bottles were then seeded with a heavy inoculum containing 2 units per c.c. of crystalline penicillin G. sodium and incubated at 37° C. for 3 days.

Under the conditions of work obtainable in this Institute, the rate of contamination observed with this medium was considerably lower than with other commonly used media. The yield of the vaccine was also fairly high, being about 200 c.c. (containing 40 billion org/c.c.) per bottle.

Haffkine Institute, Bombay-12, *May* 4, 1961.

M. K. Habbu.
H. K. Mhatre.
G. M. Govekar.

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PINK AND GREY GRANITES OF HYDERABAD

Two distinctive types of granites, namely, pink and grey, from Hyderabad (Osmania University area : lat. 17° 25′ and long. 78°31½′), have been studied in detail and the results relating to modal analyses are given in Table I. G and P indicate grey and pink granites respectively.

Table I
Modal Analyses

No.	Quartz	Potash Fels.	Perthite	Plagioclase	Total fels.	Biotite & Fe ores	Other Accessories
G_1	36·10	49·87	4·31	2·11	56·29	6·47	0·89
G_2	41·81	41·70	9·90	1·47	53·07	4·72	0·55
G_3	38·30	40·42	15·25	0·72	56·59	4·34	1·23
G_4	44·68	34·24	17·37	4·32	55·93	0·36	0·09
G_5	38·21	36·57	11·82	4·22	52·61	8·75	..
Average	38·82	40·56	12·73	2·57	54·90	4·93	0·55
P_1	27·62	42·21	20·87	5·39	68·47	2·99	0·86
P_2	24·77	36·46	29·34	1·88	67·68	7·44	0·10
P_3	21·12	53·61	18·96	1·46	74·03	4·15	0·70
P_4	28·21	67·13	..	..	67·13	3·93	0·71
P_5	27·84	35·93	24·19	4·55	64·67	7·53	0·66
Average	26·91	46·07	18·67	2·66	68·40	5·21	0·61

The grey granites show less of potash felspars and more of quartz, while the pink granites show an increase in potash felspars and a decrease in quartz, with other accessories remaining almost the same. In most cases perthites show a great variation in amount as well as the mode and extent of intergrowth. They vary from 4% to as much as 30% in content and include ordinary, microcline and antiperthites. Pyroxenes and amphiboles are absent while biotite and other associated accessory minerals are present. The presence of some blades of muscovite in the case of pink granites suggests the advanced stage of transmutation of felspars. The petrographic study suggests that the grey granites are derived from the pre-existing Dharwar Schists and the pink granites are the later phase of the granitised grey granites. This is in conformity with observations made earlier by Raja (1959)[1] in this laboratory.

The elastic properties as determined by employing the wedge method (1944)[2] for the same 10 granites as listed above are given in Table II.

Table II
Elastic Constants

No.	g	ρ	V_L	V_T	n	Y	σ
G_1	0·33	2·59	6·1	2·8	1·98	5·45	0·373
G_2	0·34	2·58	6·1	3·0	2·30	6·17	0·340
G_3	0·39	2·80	6·1	2·8	2·00	5·47	0·368
G_4	0·35	3·18	6·2	2·8	2·04	5·59	0·370
G_5	0·32	2·72	6·7	3·3	2·77	7·44	0·345
P_1	0·52	2·55	5·9	2·4	1·52	4·23	0·396
P_2	0·49	2·58	5·7	2·7	1·98	5·34	0·352
P_3	0·62	2·66	6·0	2·1	1·10	3·15	0·437
P_4	0·54	2·58	5·4	2·4	1·51	4·15	0·374
P_5	0·49	2·61	5·7	3·2	2·54	6·54	0·287

In the above table, grain size g is in mm., density ρ is in gm./c.c., longitudinal velocity (V_L), and torsional velocity (V_T) in Km/sec., Young's modulus Y and rigidity modulus n in 10^{11} dynes/cm.^{2} and σ is Poisson's ratio.

The results relating to elasticity stand nicely correlated with the geological features. In the case of pink granites the velocities are generally less than in the grey granites. This is because of the coarse grained nature and the presence of felspars in abundance in pink granites.

Geology Department, Osmania University, Hyderabad-7, *May* 31, 1961.

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A MICRO-CHAMBER FOR INCUBATION OF PLANT SECTION AND ITS GROWTH RATE MEASURING

The principle of a first plant section test, namely, the Avena coleoptile one elaborated by Bonner,[1] was so useful and convenient for the examination of the biological activity of several naturally occurring growth substances as well as synthesized compounds that, now, there are a great number of modifications of it, according to the plant genus used, specific properties of substance tested, etc.[2]

All tests embraced by this group depend on a measuring of the length of section reached after suitable period of time. However, the longitudinal expansion of coleoptile or hypocotile usually is not constant but changes with the time[3]; it is also well known, that individual differences exist between plants of the same kind, which results in variability of growth velocity of sections cut from them. So, it is evident that in some cases, especially when one wants to study the effects of two or more compounds applied one after another, there is need to measure the growth rate of individual section during the whole time of the experiment.

Fortunately, the problem has been more or less solved by a few methods,[4] and it appears that one of the best methods is the photographic technique proposed by Michel.[5] In Michel's procedure plant sections are placed in rectanguar holes cut out in discs of polyethylene sheet, floating on the surface of the solution. At the beginning of the experiment, and after suitable periods of time, petri dishes with the samples are photographed using a speed-light as the light source. An enlarged image of a finished film is projected on a sheet of paper, the ends of the sections are marked with a sharp pencil and then distances between the marks are measured with a suitable ruler; one can also make direct measurements of sections using a transparent ruler. Owing to the polyethylene disc separating each section from the other, there is no difficulty in identifying the sections, and to make it easier, in one of the holes, a standard polyethylene section is placed for reference purposes.

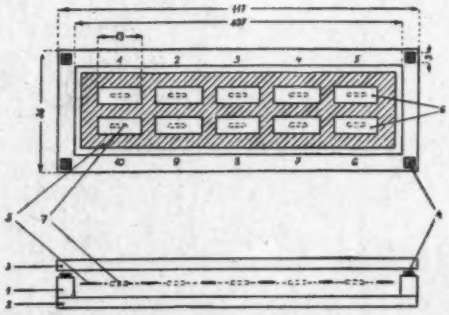

FIG. 1

In this laboratory there was need to measure growth rates of a great number of individual hypocotyl sections of *Sinapis alba*, *Linum usitatissimum*, etc. Most satisfactory results have been obtained by the author with a modified Michel's technique, especially with respect to incubation conditions: sections were not incubated in petri dishes but in a micro-chamber built up from plexiglass or another transparent, chemically inert plastic (*see* Fig. 1).

This chamber comprises the rectangular, 6 mm. thick frame (1) glued together with the basic plate (2), and from the loose top plate (3), resting upon four small supports (4), placed at the corners of the frame. To the sink so formed, surrounded by the frame, a suitable volume (usually 10 ml.) of water or tested solution is poured, and plant sections are placed in rectangular hollows[6] cut in a sheet of polyethylene strip,[5] floating on the liquid surface; to avoid a mistake in identification of sections the hollows are numbered.

The measurements of growth rates are quite easy and may be done either in the original photographic way described by Michel (especially if there are a great number of repetitions and substances tested simultaneously) or may be done directly, using a microscope with a micrometer scale, without taking sections from the chamber. The latter way, owing to small dimensions of the chamber and linear arrangement of the sections examined, is very rapid and the right reading of lengths of all ten sections may be done in 30-40 seconds.

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ON *PROLONGING* THE LONGEVITY OF THE DOG-TICK *RHIPICEPHALUS SANGUINEUS* LATR. AFTER OVIPOSITION

MOST of those who have hitherto observed the life-history of this common dog-tick (Christophers, 1907; Patton and Cragg, 1913; Hooker, Bishopp and Wood, 1912; Regendanz and Reichenow, 1931) agree that the female tick lives only for 4-5 days after completion of oviposition. Of the several female ticks observed by Nuttall (1915), one lived up to 19 days, one for 15 days, 4 for 6 days, 2 for 5 days and the rest died in 2-3 days except some which lived

only for one day after oviposition. Lombardini (1950) noticed one female tick dying on the 9th day and the rest in his collections dying in 4-5 days after oviposition.

The average number of days the exhausted females survived after oviposition in Sapre's (1945) observation was 6 days in India at 22° C. and 7,500 feet altitude, conditions altogether different from those obtainable in this area.

The present author during the course of two and a half years of research work with this tick has not seen any female tick living for more than five days after finishing oviposition under conditions prevailing in this part of India.

As far as the author is aware there is no report of a female tick reinfesting its host for one more blood-meal after completing the normal oviposition. This might be because, the activity of the tick is completely lost and as Stella (1942) has stated, hardly any trace of the ingested blood remains in the tick by the time it finished oviposition.

This is to report on the success of the author in making a good number of such exhausted and senile female ticks not only live up to a significantly long period after oviposition, but be fit for one more infestation and further experimentation. The technique employed was as follows.

With the aid of a micrometer syringe and glass needle enabling to inject a very minute quantity of any medium, a solution of sugar (commercial) was injected into the body cavity of each of a set of female ticks one day after oviposition had stopped. (These had fed on dogs before oviposition.) Each female of a second set from the same stock as above was injected with the same quantity of distilled water. A third set of females belonging to the same stock, as the above two sets, was kept without any injections.

It was observed that the second and third sets of ticks died their normal death in 3-5 days except for one in the second set which lived one day more. But the majority in the first set which had received sugar solution lived up to 31 days. Four ticks in this set lived for 15 days and one only for 4 days. The author has not so far come across any report on the success of maintaining alive such exhausted ticks after the normal period of life since oviposition. The author feels that this method of prolonging the life of ticks by injections may possibly open out new ways and means of accomplishing physiological and pathogen-transmission studies which hitherto had to contend against the immense difficulties involved in artificial feeding of the tick.

Details regarding the dosage of injections and the results of further experiments will be published later.

The author expresses his sincere gratitude to Prof. P. K. Menon for his help and guidance.

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PRELIMINARY TRIALS IN THE CONTROL OF THE MAIZE BORERS, *CHILO ZONELLUS* (SWIN.) AND *SESAMIA INFERENS* (WLK.), IN RAJASTHAN

AMONG the various pests seriously affecting *Maize*, an important food crop of south-eastern Rajasthan, the stem-borers, mainly of two different species, *viz.*, *Chilo zonellus* (Swin.) (*Lepidoptera*—Fam: Pyralidæ) and *Sesamia inferens* (Wlk.) (*Lepidoptera*—Fam.: Noctuidæ) are the major culprits concerned. Srivastava,[1] (1959) has reported these two species from Rajasthan, but found no satisfactory control by the application of insecticides. On the other hand, Mukherji,[2,3] Gupta and Avasthy,[4] and Agarwala and Prasad,[5,6] report effective control of such borers on sugarcane by the use of some of the modern insecticides, such as Gammexane and Endrin. Preliminary trials of insecticidal sprays on this crop were, therefore, undertaken in 1960 at the Rajasthan College of Agriculture, Udaipur, and the present note reports the results obtained in the control of the pests by the use of sprays of Endrin and DDT.

An experiment on the usual randomized statistical design was devised on 1/6th of an acre of a crop of Hybrid Maize. There were

4 blocks each with two treatments and one control, each being thus replicated 4 times. The following two insecticides were applied in the form of a mist-spray: (1) "Endrin 20" EC. in the form of 0·02% emulsion spray and (2) DDT 50% WP. applied as 0·25% suspension. The first treatment was given in the last week of July, i.e., about 3 weeks after sowing, the second in the second week of August and the third in the last week of August.

TABLE I

Percentage of infestation in plant counts for different treatments

Treatment	Plot No.	Number of plants in plots		Percentage of infestation	
		Total No.	Plants infested	Per plot	Mean of four
Endrin 0·02%	1	138	10	7·24	5·68
	2	170	5	2·94	
	3	146	9	6·16	
	4	94	6	6·38	
DDT 0·25%	1	149	24	16·10	12·92
	2	142	22	15·49	
	3	168	23	13·69	
	4	156	10	6·41	
Control ..	1	143	25	17·48	15·52
	2	175	31	17·71	
	3	87	9	10·34	
	4	163	27	16·56	

C.D. at 5% level — 6·12.

For estimating the percentage of damage (Table 1), every plant was carefully examined immediately after harvest in the second week of October, by stripping it to locate the exit holes, and later by splitting it for taking notes of the details of damage and the presence of live borers. In many instances, plants were found attacked at more than 3 places, while in a few cases, as many as 9 or 10 separate tunnels along with 6 or 7 borers were noticed.

From Table I, it is seen that both Endrin at 0·02% and DDT at 0·25% concentrations have had the effect of reducing the borer infestation. In the case of Endrin, however, the results are clearly significant, whereas in the case of DDT the figures are by no means significant.

Our sincere thanks are due to Shri Y. Ramachandra Rao for his valuable suggestions and Dr. A. Rathore, Principal, Rajasthan College of Agriculture, Udaipur, for laboratory facilities kindly provided.

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A RARE SEROTYPE OF *PASTEURELLA MULTOCIDA*, CAUSING PNEUMONIA IN SHEEP IN INDIA

PRELIMINARY results of studies on the prevalence of various serotypes of *Pasteurella multocida* in different species of animals and birds in India were published in an earlier communication[1] from this laboratory. As many as 25 strains isolated from cases of enzootic pneumonia in sheep in the States of Uttar Pradesh, Himachal Pradesh and Jammu and Kashmir were serologically typed when 12 cultures were found to belong to Roberts' type I (Carter's type B), 2 to Roberts' type IV (Carter's type D) and eleven isolates could not be accommodated into any of the recognised serogroups I to IV of Roberts[2] and the newly delineated type V of Hudson.[3] All these strains could not be typed as they were avirulent to mice and lacked the capsular polysaccharide and somatic lipopolysaccharide fractions that were shown to determine type-specificity.

Recently a strain (CS) of *Pasteurella multocida* of low virulence was isolated in pure culture from cases of pneumonia in sheep at one of the state farms at Chinnasalem in Madras. Complete consolidation of apical and cardiac lobes was a cardinal feature and the condition led invariably to death of the affected sheep within three days. Pneumonic lungs were screened for the presence of a virus with entirely negative results. The unusual features exhibited by the CS strain of *P. multocida* were (1) fermentation of maltose but not xylose and arabinose, (2) ability to elaborate a soluble hæmolysin active against erythrocytes of sheep but not any other species, (3) absence of hæmolysis on blood agar plates containing 5% (v/v) of horse, ox, sheep, goat, fowl, pigeon, rabbit, guinea-pig and mouse blood, and (4) possession of Forssmann heterophile activity reported earlier only with cultures isolated from rabbits.[4–7]

In the indirect bacterial hæmagglutination and hæmolysis tests, extracts prepared from the CS strain by autoclaving at 15 lb. pressure for 30 minutes either broth or yeast-extract agar-

grown cell suspensions (adjusted to match in opacity to tube 2 in the Burroughs Wellcome standard scale) gave a titre of 1 : 320 and 1 : 1280 respectively, with standard sera representative of type III but only 1 : 40 when tested against type II.

The type-specificity of the soluble antigen was demonstrated in the corresponding inhibition tests recently developed in this laboratory. Autoclaved extracts diluted to 1:32 to 1:64 inhibited agglutination and lysis of sensitised erythrocytes by type III antisera. In the complement-fixation technique carried out on the lines of Rice *et al.*,[8] titres of 1 : 64 and 1 : 4 were elicited against type III and type II antisera, respectively. The immunological homogeneity was shown in gel-diffusion tests when a single line appeared on Ouchterlony plates when extracts were diffused against homologous and standard type III whole-cell or crude extract rabbit antisera.

The strain could not be typed by Roberts' passive mouse protection test as it failed to kill mice except when given as meat broth cultures. It killed pigeons within 4 days but proved avirulent to rabbits.

Pneumonia was successfully induced in susceptible lambs when they were infected by intranasal, intratracheal and subcutaneous routes and *P. multocida*, type III, was recovered from pneumonic lungs of experimentally infected lambs, thus, fulfilling the modified Henle-Koch's postulates. Intravenous inoculation of cultures proved fatal to adult sheep within 12 hours. A tetravalent oil-adjuvant vaccine has since been developed for field trials on active immunisation of sheep on the affected farms.

This is the first report of primary pneumonia in sheep due to *P. multocida*, type III. The isolation of yet another immunotype adds to the complexity of the problem of biological prophylaxis against pasteurellosis in sheep. This serotype had not been isolated earlier, save from a cat,[1] in India.

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OBSERVATIONS ON THE ROTIFERS FROM SHALLOW PONDS IN DELHI

ALTHOUGH rotifers are valuable food of carp frys, only a few workers have attempted to study their ecology ; the most notable ones are Anderson[1] and Edmondson and Hutchinson.[2] Alikunhi, Chaudhuri and Ramachandran[3] have observed the quantitative variations of rotifers in a few nursery tanks in Cuttack, though annual population study was not attempted. Das and Srivastava,[4] during the course of a general study of the plankton of a tank in Lucknow, have made a few remarks on the rotifers present.

The present note deals with the periodicity, species composition and diurnal migration of rotifers from five fish ponds situated in different blocks of Delhi. The tanks studied are Roshanara tank, Indranagar tank, Naini lake, Shahdra Stocking tank and Shahdra Nursery tank, of which the last was dry in June and July. The observations are based on the analysis of data from October 1958 to September 1959.

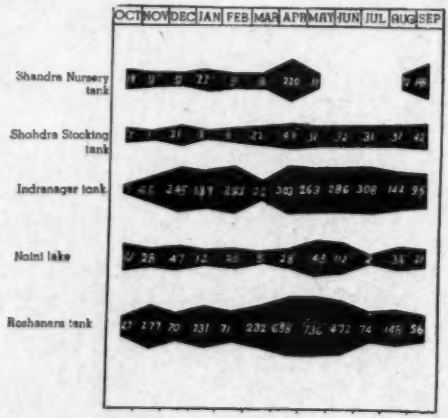

FIG. 1. Quantitative variations in rotifer population in different tanks.

The quantitative variations in the rotifer populations are represented in Fig. 1, which is prepared after Lohmann's Spherical Curve Method cited by Birge and Juday.[5] The numbers indicated in Fig. 1 represent the population, as organisms per litre, which is an average

of two fortnightly samples. Generally, a major pulse of rotifers was discernible in all the tanks in the summer months of April to July, though in Roshanara tank and Indranagar tank they showed minor pulses in different months. Thus, a summer periodicity may be attributed to the rotifers in Delhi waters. Pennak,[6,7] from his observations has concluded that there is no seasonal periodicity in North American rotifers. Wesenburg-Lund[8] has shown that their seasonal variations in Danish waters are not very marked. The present observations point to the occurrence of a summer periodicity in rotifers. It is likely that in tropical waters they may show a summer maximum, but more extensive work is needed to confirm this.

A notable feature of the species composition of the rotifers from the ponds in Delhi is the simultaneous occurrence of two or more species of the same genus in a single collection. For instance, it was seen that *Brachionus* was represented by more than two species, even up to four, in many samples and it was the only genus observed to have such a species composition. Pennak[9] has observed that in a few genera of rotifers, two species of the same genus appear occasionally in a single sample. According to the present author, it is for the first time that more than two species of the genus *Brachionus* is reported from a single collection. The different species that have entered into such a species composition are *B. calyciflorus* Pallas, *B. falcatus* Zacharias, *B. quadridentatus* Hermann and *B. bidentata* Anderson. Another example is the genus *Filinia* which showed two species in a single collection.

Pennak[9] has noted that whenever two species of the same genus are present, one is almost always more abundant than the other. But an analysis of the present data does not reveal any significant dominance of one species over another. Moreover, there were instances when more than two species of *Brachionus* had appeared at one time, and in those cases two or sometimes three species were seen to exist in almost equal number. The food habits of different species of *Brachionus* are not well understood, but it is apparent from the species composition that interspecific competition for food in this genus is very little.

The total number of species of plankton rotifers so far recorded from the tanks under study and also from the survey of 25 other tanks in Delhi State, is thirty-two. Either *Keratella valga f. tropica* Apstein or the (different) species of *Brachionus* always showed numerical superiority over the other rotifers. This feature appears to be characteristic of the tanks in Delhi, which have pH always above 8·0.

George[10] has made observations on the diurnal migration of rotifers, which differ from the observations of earlier workers. In Roshanara tank, the maximum rotifer population was noted at the surface at 10 a.m. while in Naini lake it was at 4 p.m. Vaas and Sachlan[11] have observed the rotifers to rise at night in two shallow ponds in Indonesia. Investigations on the factors that influence their diurnal migration in tropical waters should be an interesting field of study.

The author is indebted to Dr. M. Chandy under whose guidance the present work was carried out and to Prof. B. R. Seshachar for critically reading the manuscript and for providing facilities. For the grants-in-aid of the scheme on Fish Culture and for the award of a Junior Research Fellowship, the author's gratitude to the Council of Scientific and Industrial Research is recorded.

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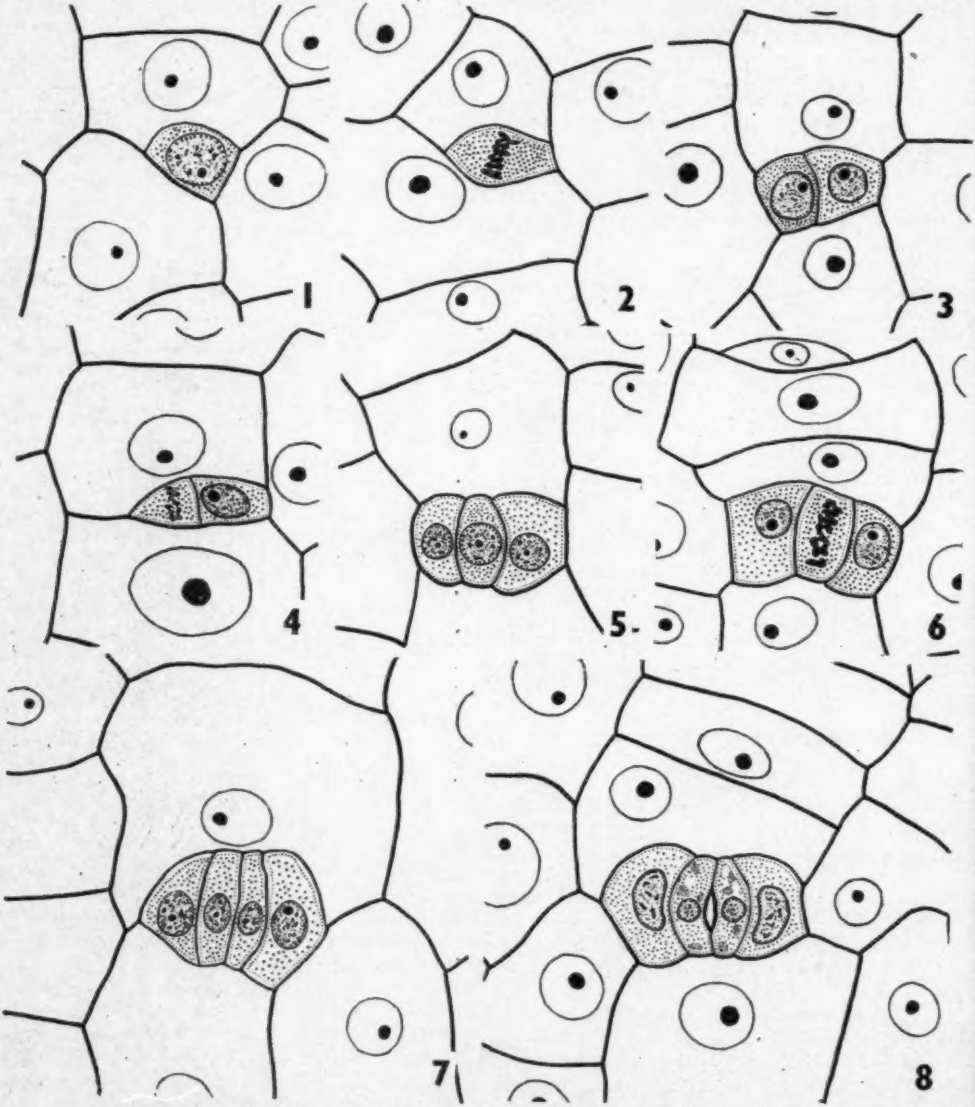
THE DEVELOPMENT OF STOMATA IN *LINUM USITATISSIMUM* L.

The role of stomata in various physiological processes is well known. That they also have a systematic significance has been clearly brought out by several writers.[5,6] Though developmental studies have been made on the stomata of many gymnosperms, the information on angiosperms is still rather scanty. The chief accounts are by Campbell,[3] Porterfield,[7] and Flint and Moreland,[4] all dealing with the family Gramineæ. The stomata of the Crassulaceæ have been investigated by Strasburger,[9] and Yarbrough.[10] Recently Bondeson[2] described their development in *Trochodendron, Tetracentron* and *Drimys*. Artschwager[1] and Rao[8]

surveyed the stomatal types in the Graminеæ and the Magnoliales but the stages of development were not taken into account by them. The present paper deals with the development of the stomata in *Linum usitatissimum*.

The leaves were collected from plants in the Botanical Garden of the Delhi University. Portions of epidermal peels at various stages of development were fixed in acetic-alcohol (1 : 3). These were stained with iron-acetocarmine and



FIGS. 1-8. *Linum usitatissimum*. Development of stomata, × 1,026. Fig. 1. Meristemoid. Fig. 2. Meristemoid undergoing first mitotic division. Fig. 3. Unequal cells formed after the first mitotic division. Fig. 4. One of the daughter cells of the meristemoid undergoing second mitotic division. Fig. 5. Advanced stage showing two subsidiary cells and the median guard mother cell. Fig. 6. Guard mother cell in division. Figs. 7-8. Young and mature stomata.

later dehydrated through an acetic acid-butyl alcohol series and finally mounted in canada balsam.

The epidermis of the lower surface of the leaf consists of uninucleate, richly cytoplasmic and hexagonal cells. The development of a stoma begins with the formation of a transverse septum on one side of an epidermal cell, producing two unequal cells (Fig. 1). The smaller cell can be distinguished from its mother cell and other epidermal cells by its lenticular shape, dense cytoplasm, and a prominent nucleus which occupies almost the entire cell cavity. This cell functions as the meristemoid or stomatal initial.

The meristemoid soon increases in size, especially in length ; its nucleus divides and the chromosomes at the metaphase may be placed vertically (Fig. 2) or diagonally to the long axis of the initial. The daughter cells thus formed are again slightly unequal in size (Fig. 3). The smaller of the two has denser cytoplasm and a larger nucleus. In Fig. 4 this cell is seen in division resulting in the formation of two cells (Fig. 5). These, together with the undivided cell, constitute a row of three cells (Fig. 5). The median cell now acts as the guard mother cell. In the beginning it is smaller than the lateral cells but later enlarges and divides vertically (Fig. 6) forming two equal cells (Fig. 7) which gradually become bean-shaped and function as the guard cells. The two flanking cells constitute the subsidiary cells. These are distinguishable from the other epidermal cells by their lateral position, smaller size and oblong shape. The mature stomata (Fig. 8) are, therefore, of the Rubiaceous or paracytic type.[6] Since the guard cells and the two subsidiary cells originate from the same meristemoid, the development conforms to the syndetocheilic type.[2,5]

I am indebted to Professor P. Maheshwari and Dr. R. N. Kapil for their keen interest and encouragement.

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GENETICS OF DWARF GROWTH IN COMMON WHEAT

IN a previous communication the present authors reported about "grass clump" or "dwarf growth" formation in a cross involving the wheat varieties Gabo and R.S. 31-1.[1] Since no seed formation takes place when the crossed seeds are grown because of the premature death of the seedlings after the grass clump formation, the cross was again attempted by introducing a bridging variety. Wheat variety A. 115, a local selection from Madhya Pradesh, was used as bridging variety and was crossed with Gabo in 1957-58. The normal F_1 obtained from this cross was crossed with variety R.S. 31-1 in the years 1958-59. The F_1 of this three-way-cross was grown during 1959-60. The F_2 progeny of the normal F_1 plants has been planted during 1960-61. The data is summarised in Table I.

TABLE I

Reaction of the F_1 and F_2 of the three-way-cross (Gabo × A. 115 × R.S. 31-1) to dwarf growth

Material	No. of plants			X_2	P value
	Dwarf	Normal	Total		
F_1 observed ..	11	12	23	..	..
F_1 expected (1 : 1)	11·5	11·5	23	0·043	·95-·50
F_2 observed (raised from normal F_1 plants)	..	323	323	..	..

About the inheritance of dwarf growth in varieties of common wheat, McMillan[2] published an extensive article and on the basis of his theory most cases of dwarf growth can be explained. Assuming only one system of interacting factors, the occurrence of grass clumps can be explained on the basis of three main groups of factors, which are designated as *A*, *I* and *G*. Each group may consist of complementary and polymeric factors. The *G* group must be dominant for grass clumps to develop. If the *I* group is dominant (and the *A* group is not) it inhibits the expression of *G* and results in normal ; but a dominant *A* group prevents the action of *I* in inhibiting *G*. One factor pair in each of the *I* and *G* groups is sufficient to account for the results ; but in the group *A* two pairs of complementary factors, designated *Aa* and *Bb* are necessary. Both *A* and *B* must be

present in the dominant form to prevent *I* inhibiting *G*.

According to McMillan's theory Gabo has the genotype *AbIG* (Class I). R.S. 31-1 then may have the genotype *ABig* (Class II) or *aBig* (Class IV) and the bridging variety A. 115 of the three-way-cross may have *abIG* (Class III) or *abIg* (Class V). Dependent on the genotype of R.S. 31-1 and A. 115, there are four possibilities of their combination. The segregations thus obtained in this three-way-cross are enumerated in Table II.

TABLE II

Assignment of genotype under possible F_1 and F_2 segregations of the three-way-cross

	Variety and genotype	F_1 (three-way-cross)	F_2 progeny of normal F_1 plants
1	R.S.31-1 — *ABig* A.115 — *abIG*	All dwarf	..
2	R.S.31-1 — *aBig* A.115 — *abIG*	1 dwarf : 1 normal	All segregating into 13 normal : 3 dwarf
3	R.S.31-1 — *ABig* A.115 — *abIg*	1 „ 1 „	Wholly normal F_2's
4	R.S.31-1 — *aBig* A.115 — *abIg*	1 „ 3 „	1× (13 normal : 3 dwarf) 2× wholly normal

As observed in Table I, the F_1 of the three-way-cross has shown a close fit to 1 : 1 ratio and the F_2 progeny of the normal F_1 plants in the cross has shown no segregation and all plants have come out to be normal. According to McMillan's theory, where genotype of Gabo has already been designated as *AbIG* for dwarf growth, the genetic constitution for R.S. 31-1 can be suggested as *ABig* and that of A. 115 as *abIg* (Table II).

On the basis of the proposed genetic constitution of the varieties in the cross, the dwarf growth is mainly due to the dominant effect of Group *G* in the cross involving Gabo and R.S. 31-1, and its suppression in the cross Gabo × A. 115 is due to the presence of Group *I* in dominant form. In the cross Gabo × R.S. 31-1, Group *I* also being dominant could have prevented Group *G* in effecting the dwarf growth but since both *A* and *B* are present in the dominant form, it has prevented *I* inhibiting *G*.

Authors are grateful to Dr. M. S. Swaminathan, Cytogeneticist, I.A.R.I., New Delhi, and Dr. J. G. Th. Hermsen, Institute of Agricultural Plant Breeding, Wageningen, Netherlands, for their valuable suggestions in the preparation of this note.

Agric. Research Station, Durgapura, Jaipur, Rajasthan, *February* 23, 1960.

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RESISTANCE OF PADDY VARIETIES TO BLAST IN UTTAR PRADESH

BLAST (*Piricularia oryzae* Cavara) is the most serious disease of paddy and although it is confined at present to a few pockets in some acres, it may eventually spread to new areas and cause more damage. With a view to evolve high yielding paddy varieties, resistant to blast, a programme of testing selected varieties in co-operation with the Assistant Economic Botanist (Paddy) was initiated in 1958 at Kanpur and the present paper gives a summary of the data collected on twenty-nine paddy varieties and cultures during the last three seasons.

Since the severity of blast is correlated directly with excessive nitrogenous manuring, the trials were undertaken at the Usar Reclamation Farm at Chakeri near Kanpur where due to the supply of sewage water for irrigation and heavy application of nitrogenous manure, moderate to heavy infection of blast has been observed every year. The selected varieties were grown in randomised blocks with four replications. Regular observations of infection rating of *Piricularia oryzae* were taken from the milk stage until the maturity of the crop because the disease appeared only at this time at Chakeri. Neck-rot infection was not common, hence detailed observations were taken according to Padmanabhan and Ganguly's[1] technique on the type and intensity of spotting on fifty leaves selected at random from every variety. According to this technique the type of spots and the number of each type of spots are scored for a set of infected leaves and the final infection rating is given by multiplying the two numerical values and finally classifying the product to indicate the resistance, moderate resistance, moderate susceptibility, and susceptibility of a particular variety to blast. According to these categories of resistance, used in the tests reported here, the twenty-nine paddy varieties and cultures are classified as follows :—

Resistant : Nil.

Moderately resistant : S.M. 8, T. 100, N. 12, T. 22-A, T. 36, H. 755, B.J. 1, T. 3 and C.P. 9.

Moderately susceptible : T. 1, C.H. 55, P.T.B. 10, C.H. 10, C.P. 6, T. 6522, C.H. 13, N.S. 41, T. 21, N.S.J. 163, T. 136, N.S. 42 and C.O. 13.

Susceptible : N.S. 135, N.S.J. 98, C.H. 4, N.S.J. 161, N.S.J. 157 T. 137 and N.S. 134.

Thanks are due to the Director, Central Rice Research Institute, Cuttack and the Assistant Economic Botanist (Paddy), Nagina, U.P., for the supply of paddy varieties and cultures and to the Agricultural Chemist to Government, Uttar Pradesh, Kanpur, for providing facilities for the conduct of these trials at the Usar Reclamation Farm, Chakeri.

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DISTRIBUTION OF *CUCUMIS* VIRUS 2C IN MOSAIC-INFECTED BOTTLEGOURD (*LAGENARIA SICERARIA* STANDL.) PLANTS

IT is often noticed that various organs of a virus-infected plant do not always possess the casual virus in them even in spite of the systemic nature of the infection. *Cucumis* virus 2 C infects bottlegourd plants systemically causing a mosaic disease.[1] Generally the leaves of infected plants alone show apparent symptoms of disease producing a light and dark-green mottle with occasional vein banding and puckering. The present investigations were undertaken to ascertain whether all the organs of an infected host plant actually possess the virus in them.

Various organs of a mosaic-infected bottlegourd plant and the parts composing each organ were separately tested for the presence of the virus. Extracts from each of the plant part were made by macerating the tissue in distilled water in the proportion of one ml. to each gram of plant tissue. Healthy bottlegourd plants were inoculated by gently smearing the leaves in presence of carborundum powder. Control plants were inoculated with extracts from corresponding parts from a healthy bottlegourd plant.

Results of infectivity tests are shown in Table I.

TABLE I

The presence or absence of mosaic virus in various organs of virus-infected bottlegourd plant

Plant parts	No. of plants inoculated	No. of plants infected	Presence (+) or Absence (−) of virus
Root ..	5	5	+
Root hair ..	5	4	+
Stem ..	5	5	+
Tendril ..	5	5	+
Leaf ..	5	5	+
Petiole ..	5	5	+
Lamina ..	5	5	+
Flower ..	5	5	+
Calyx ..	5	5	+
Corolla ..	5	5	+
Stamens ..	5	5	+
Pollen ..	5	5	+
Pistil ..	5	4	+
Fruit ..	5	5	+
Epicarp ..	5	5	+
Mesocarp ..	5	5	+
Endocarp membrane ..	5	5	+
Seed ..	5	5	+
Testa ..	5	5	+
Tegmen ..	5	5	+
Embryo ..	5	5	+
Cotyledons ..	5	5	+
Axis (Radicle & Plumule)	5	0	−

The bottlegourd mosaic is not seed-borne.[1] The presence of active virus both in the pollen as well as in the embryo, therefore, is of special interest because viruses that are not seed-borne generally are neither known to enter the pollen nor the embryo.[2] The absence of seed transmission in some viruses may be due to their inability to infect and survive in the young gametophytic and meristematic tissues.[3] How long does the mosaic virus survive in the embryo and in other parts of the bottlegourd seed, therefore, needs to be determined. Investigations in this direction are in progress.

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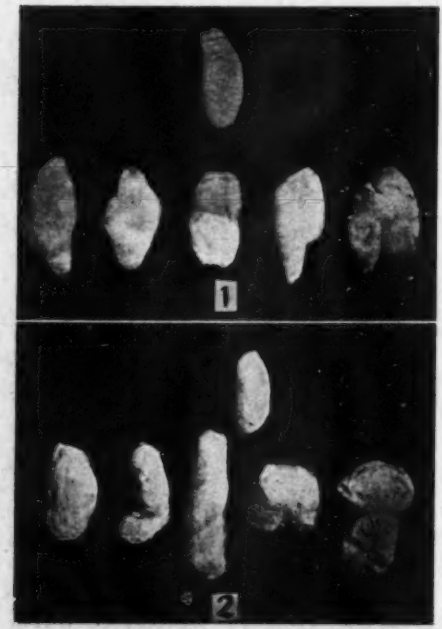
OCCURRENCE OF DOUBLE-COCOON FORMING PHENOMENON ON *PHILOSAMIA RICINI* HUTT. AND *ANTHERAEA ASSAMA* WESTW.

DOUBLE-COCOON formation is reported[1] to be the peculiar phenomenon to *Bombyx mori* Linn.

Observations made in the cocoon crops of *Philosamia ricini* Hutt. and *Antheræa assama* Westw., however, revealed the presence of the similar type of cocoons and numbers collected of such type of cocoons were 9 and 5 out of a total of 8136 and 7318 cocoons respectively. Eight of these abnormal cocoons of *P. ricini* were formed by two larvæ and one by three. On examination, the sex of the associated larvæ



FIGS. 1–2. Fig. 1. Some double cocoons (lower row) of *P. ricini* with a normal one (upper row). Fig. 2. Some double cocoons (lower row) of *A. assama* with a normal one (upper row).

of these nine cocoons was found to be female. In *A. assama*, all the cocoons contained only two larvæ. Sexes were both female in seven cases, both male in one case and one male and one female in four cases. In two cases, sex of one of the larvæ was female and in one case, it was male. Sex of their partners could not be identified. It was noted that the double cocoons of *P. ricini* were collected both from overcrowded and thinly populated cocoonage. Attempt made by an experiment to force the larvæ of *P. ricini* and *A. assama* to form double cocoon by providing them inadequate space was without success.

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ON THE FLORAL MORPHOLOGY OF *CURCUMA LONGA* L.

IN a recent communication[2] in this Journal concerning the "flowering behaviour and anthesis of *Curcuma longa* L.", the authors refer to "two sterile stamens attached at the base of the pistil". This is also indicated by their Figs. 1 and 2. On an examination of material of the same species in the possession of the present writer, these are found to be actually the two epigynous nectaries. It may be observed that the epigynous nectaries are of almost universal occurrence in the family. That the glands are modified stamens is an age-old conception[1] which, although corroborated by some later investigators,[4] is to be regarded as merely of historical interest in the light of modern researches. On the basis of anatomical evidence,[5-7] it has been shown that these are special vascularized emergences of carpellary tissue and are not in any way connected with the androecium. It may be pointed out that these are the last organs to appear in the zingiberaceous flower which has been the opinion of even an earlier writer,[3] and are, perhaps, organs of later origin as well. In form, structure, development and vasculature, these organs suggest no connection with the androecium and are best interpreted as nectariferous appendages of the ovary, anatomical evidence for which, amidst others, is conclusive.

Studies in the vascular anatomy of the flower of a number of species of this family are in progress and the results will be published elsewhere.

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REVIEWS

Organic Electronic Spectral Data—Vol. I (1946-52). Edited by M. J. Kamlet; Vol. II (1953-55). Edited by H. E. Ungnade. (Interscience Publishers Inc., 250, Fifth Avenue, New York-1), 1960. Pp. xiv + 1208. Price: Vol. I, Subn. Copy $ 25.00. Single $ 28.50; Pp. x + 919; Vol. II, Subn. Copy $ 15.00. Single $ 17.50.

Among the various physical methods of organic analysis the spectroscopic methods have taken a predominant place firstly because of the wealth of information that can be obtained from them and secondly because of the comparatively easy techniques involved, especially with the recent developments in the instrumentation employed in their study. The three recognized methods in this field are the ultra-violet absorption spectroscopy, the infra-red spectroscopy and the Raman effect spectroscopy. These three methods give almost complete information about the molecule regarding structure, functional groups, bondage, molecular forces, distances and angles.

With the advent of photoelectric spectrophotometry the study of the electronic spectra of molecules has reached a high degree of perfection and standardization. With the precise data thus available and with the specificity in the relation between structure and the maximum wavelength absorption in the ultra-violet, it is now possible to go a long way in the empirical interpretation of organic molecular structure.

Whereas comprehensive catalogues of organic data on Raman and infra-red spectra are presently to be had, there has appeared, as yet, no such compendium of ready reference for ultra-violet absorption data. The projected series of volumes whose publication has been undertaken by the Interscience Publishers will supply this need. The hugeness of the task involved in this undertaking can easily be realized from the size of the first two volumes that have come for review.

Essentially the data given are $\lambda_{max.}$ and log ϵ for organic molecules. Volume I of 1,208 pages, covers the data abstracted from journals published during the years 1946-52 and Volume II of 919 pages, those for the years 1953-55. Each page contains four columns. The first column gives the compound and the molecular formula. The arrangement of compounds corresponds in most respects with that followed in the Chemical Abstracts Formula Index. The second column contains the solvent or phase in which the spectrum was studied. The numerical data in the third column represent wavelength ($\lambda_{max.}$) values in $m\mu$ for all maxima, shoulders and inflections. The logarithm of the corresponding molar absorptivity (log ϵ) is given in parenthesis. The last column gives the reference in code numbers explained at the beginning in the text.

It should be noted that data are included even if known with absolute certainty to be incorrect, as such information may often be quite valuable by demonstrating the operation of otherwise unknown chemical or photochemical transformations.

Abstraction of data has been done from 65 journals. The bulk of the data has been abstracted from *Journal Chem. Soc.*, *Jour. Am Chem. Soc* and *Helv. Chim. Acta*. The two Indian Journals included in the list are the *Proc. Ind. Acad. Sci.* and *J. Ind. Chem. Soc.* Vol. III will cover data for 1956-57. Vol. IV for 1958-59 and Vol. V for 1960-61. These volumes are indispensable for organic research libraries.

A. S. G.

Introduction to Statistical Thermodynamics. By T. L. Hill. (Addison-Wesley, Pub. Co., Inc., Reading, Massachusetts, U.S.), 1960. Pp. xiv + 508. Price $ 9.75.

The author of this book is well known for his earlier work *Statistical Mechanics* which was published a few years ago. The present volume is intended primarily as a text-book for courses in physics or chemistry, and provides a quite extensive coverage of topics of current interest in equilibrium statistical mechanics.

The book is divided into four parts. Part I (Chapters 1 and 2) is concerned with the principles or postulates of statistical mechanics, Part II (Chapters 3-13) contains applications of the principles developed in the previous part to systems of independent molecules (*e.g.*, an ideal gas) or of other independent subsystems. The more complicated but also more interesting problems which arise when molecules can no longer be treated as independent of each other (because of intermolecular forces) provide the subject-matter of Part III (Chapter 14-21). While most of the applications in Parts II and III have to do with classical (high-temperature)

limit of quantum statistics, Part IV (Chapter 22) is concerned with problems for which the classical limit is not valid (*e.g.*, helium gas at low temperatures). In this chapter, topics such as Bose-Einstein and Fermi-Dirac statistics, helium at low temperatures, inter-molecular interactions, are treated in detail.

The book will provide a valuable text for students of physics and chemistry.

K. S. V.

Progress in Endocrinology : *Proceedings of a Symposium held at Edinburgh, August* 1959. Part I—*Neuroendocrinology and Endocrinology of the Thyroid and Parathyroid Glands*, 1960. Pp. 166. Price 45 *sh*.

Part II—*Biochemistry and Biological Actions of Steroids and other Hormones*, 1961. Pp. 167. Price 45 *sh*.

Edited by K. Fotherby, J. A. Loraine, J. A. Strong and P. Eckstein. (Cambridge University Press, London, N.W. 1).

The two volumes which form No. 9 and No. 10 in the series *Memoirs of the Society for Endocrinology* record the proceedings of a conference held in August 1959 to survey the current knowledge on the topics mentioned in the title.

In the First Part twenty-three papers with subsequent discussions by anatomists, physiologists, biochemists and endocrinologists, together with extensive bibliographies are reproduced in full. The names of the contributors make a formidable list of internationally known experts. Each paper summarizes the knowledge in the particular field and indicates the results of the researches of experts who participated in the Conference. Most of the information has not been previously published and many new and fascinating perspectives are opened up by ideas developed during the course of the discussion.

The Second Part contains 45 assorted papers on (i) Steroid Biochemistry ; (ii) Biological Actions and Interrelationships of Steroids and other Hormones and (iii) Endocrine Glands and their Relationship to Cancer.

In the opening paper, 'Some recent advances in œstrogen biochemistry', Prof. G. F. Marrian has reviewed the recent work on the isolation of eight new œstrogen metabolites. A spirit of enthusiasm is found to permeate through this paper and the pathos in the "swan song" is subdued. A novel, enzymic method for the determination of plasma corticoids, which has been suggested in a paper appears to be of practical value. The finding, in another paper, that there is an alternation in the normal secretion pattern of an adrenal cortex in hirsute women undergoing ACTH administration, is of clinical interest.

Most of the papers from Section (ii) are experimental in nature and preliminary in character. The introductory note to Section (iii) by Prof. C. Dodds and the paper on "The Endocrine System and Cellular Autonomy" by Prof. A. Haddow are informative and thought-provoking. In one of the papers, dealing with endocrinological aspects of mammary cancer, Prof. O. Mühlbock has shown that susceptibility of the target organ may be playing a decisive role in the production of cancer. Although, the nature of susceptibility is yet unknown, it is the core of the cancer problem and the ultimate objective of much of the present-day research. Judged from this aspect the paper is very important.

The two memoirs afford the reader a bird's-eye-view of the progress of the varied types of endocrinological studies at present in progress in several laboratories. It is of special value to those who are actively engaged in endocrinological research.

V. R. KHANOLKAR.

Preparative Methods of Polymer Chemistry. By Wayne Sorenson and Tod W. Campbell. (Interscience Publishers, Inc., New York), 1961. Pp. viii + 337. Price $ 10.50.

The available books on polymers deal with the kinetics and mechanism of polymerization and with technology. This book is unique and fulfils a very real need, describing detailed procedures for the laboratory synthesis of a large number of polymers. It is a most valuable addition to the library of polymer chemists and technologists as well as synthetic organic chemists. Methods described in journals and patents have been collected and supplemented by the practical experience of the authors and their colleagues in the Du Pont Co. A brief introduction is followed by six chapters with the following titles : preparation, fabrication and characterization of polymers ; polycondensation and hydrogen transfer polymerization ; addition polymers from unsaturated monomers ; ring opening polymerization ; nonclassical routes to polymers ; and synthetic resins. A typical preparation is poly (hexamethylenesebacamide) (6-10 nylon), known sometimes as the nylon rope trick ; the procedure is described in such detail that no difficulty should be encountered in duplicating it. However the book does not merely consist of preparative details, and experimental methods are preceded by an adequate discussion of the

principles involved. The chapter on addition polymerization gives a very clear account of stereospecific polymerization including the preparation of catalysts. The chapter on non-classical routes to polymers deals with cyclo-polymerization, polymerization of carbonyl compounds, monoisocyanates and diazo-compounds, preparation of poly-p-xylene, polymerization of norbornylene, 1-*n*-polyamides, and polyphenylene ethers. The chapter on synthetic resins is relatively short and limited in scope. The sketchy appendix on sources of equipment and chemicals does not fulfil a useful purpose; on the other hand, the three indices on initiator systems, reaction systems, and polymerization through functional groups, which precede the general index, are a valuable guide to the basis on which polymers are designed. K. V.

Butterworths Publications in Chemistry. By C. W. Wood and A. K. Holliday, 1960.
Inorganic Chemistry. (An Intermediate Text). Pp. viii + 393. Price 21 *sh.*
Physical Chemistry. (An Intermediate Text). Pp. viii + 322. Price 21 *sh.*
Organic Chemistry. (An Introductory Text). Pp. xxii + 321. Price 21 *sh.*

These three books, written by an experienced senior Science Master of a school and a senior University Lecturer in inorganic and physical chemistry, cover the chemistry of the standard required for "the C.E.C. advanced and scholarship level examinations of the various examining bodies" and for "the first year course leading either to a degree in Chemistry or to a degree in some other science subject" in Britain. In each of them, due importance is given to the historical approach to new discoveries and new theories so as to arouse the curiosity and interest of the student in the newer developments in the three main branches of chemistry. Certain topics such as atomic structure, classification of elements and valency figure both in the inorganic and physical chemistry books, valency appearing also in the organic book, but with variation in detail and emphasis in keeping with the subject of the book.

The inorganic book deals with elements and their important compounds from the viewpoint of the periodic classification, attempt being made to explain their physical and chemical properties in terms of such fundamental factors as electronic structure, type of bond, bond length, ionic radius, dipole moment, paramagnetism and so on. In view of recent developments, boron, fluorine and titanium and their compounds are described in greater detail than would be expected in a book of Intermediate standard. Complex, clatharate and 'sandwich' compounds are also included to give an idea of the wide variety of inorganic compounds. The last chapter on lanthanides and actinides brings out the significance of transitional and transuranium elements.

Atomic structure and valency are treated in greater detail in the physical chemistry text than in the previous one, with inclusion of the structure of the nucleus, nuclear fission, formation of transuranium elements and atomic orbitals. Particularly well-written are the chapters on solids, chemical equilibria and kinetics (the difference between the two being indicated very clearly), the ionic theory (modern concepts of acid and base being included), catalysis (with numerous examples of theoretical and practical value), oxidation and reduction, and colloids. Model problems are worked out in some cases.

Organic compounds are classified and studied according to their reactive, functional groups. One of the later chapters on structure and reactivity discusses the relation between reactivity and type of chemical bond, introducing with appropriate illustrations the concepts of resonance and delocalised orbitals. Methods of separation and purification including even chromatography, determination of constitutional formulæ utilising infra-red, X-ray and nuclear magnetic resonance data, and isomerism in its various forms are described in the last chapters to enable the student to appreciate these better after a fair knowledge of organic compounds.

All the three books, written in a clear, simple language, can very well serve as an excellent introduction to the new three-year degree course in Chemistry.

L. M. YEDDANAPALLI.

Metabolic Pathways, Vol. I. Edited by D. M. Greenberg. (Academic Press, New York, London), 1960. Pp. xv + 572. Price $ 18.00.

The volume under review is the second edition of *Chemical Pathways of Metabolism* and in editing the same, Dr. Greenberg has taken note of the rapid progress made in recent years on the specific enzyme functions for biotin and for Vitamin B_{12} and of the metabolism of the carotenoids, vitamins and enzymes. Twelve topics dealing with various chemical aspects of metabolism have been written by scientists who are actively working in the respective fields. The subjects covered are free energy and entropy in metabolism, mitochondrial system of enzymes, glycolysis, the tricarboxylic acid cycle, other

pathways of carbohydrate metabolism, biosynthesis of complex saccharides, fatty acid oxidation and synthesis, ascorbic acid, metabolism of phosphatides, metabolism of sterols, metabolism of steroid hormones as well as carotenoids and Vitamin A. Entropy changes are of great interest to biochemists, as they give an idea of the structural changes of the products relative to the reactants. The cells of all aerobic organism contain specialised structures such as mitochondria which have enzyme systems necessary for basic cellular functions. Various aspects of carbohydrate, fat, vitamin and sterol metabolism are also considered in the light of recent research work on these subjects. In short, the present volume can be considered a veritable mine of information and the contributors are to be congratulated for presenting comprehensive reviews in such a lucid and graphic manner. The printing and general get-up of the volume are excellent and are in keeping with the highest traditions of Academic Press.

P. S. SARMA.

Introduction to Biochemistry. By E. O. F. Walsh. (The English University Press, 102, Newgate Street, London, E.C. 1), 1961. Pp. viii + 454. Price 27 *sh.* 6 *d.*

This will be an ideal introductory text-book on biochemistry for students of biology and medicine who having already acquired a basic knowledge of chemistry would like to extend their interest of study to the exciting field of the chemistry of life.

The subject-matter has been judiciously chosen and logically arranged. The language is that of an experienced teacher, simple and lucid. The book will not only provide the students with a fundamental understanding of the subject but also stimulate interest in them for further reading.

After the first few chapters dealing with the composition of living matter, enzymes, and the chemistry of digestion, the author describes in detail the role of phosphorus in the chemistry of life, metabolism of carbohydrates, cellular respiration and photosynthesis. These are followed by chapters on the metabolism of lipids and that of nitrogen. Separate chapters deal with blood, vitamins, and hormones.

The book can be recommended not only to graduate students of biochemistry but also to more advanced readers of the subject who will find in it a wealth of information and also in places the author's own views on important unsolved problems in this field of study.

A. S. G.

Plant Physiology—*A Treatise—Cellular Organization and Respiration.* Edited by F. C. Steward. (Academic Press, New York; India: Asia Publishing House, Bombay-1), Vol. I A, 1961. Pp. xxiv + 331. Price $ 13.

We have before us the first volume, or shall I say, sub-volume of the much awaited treatise in *Plant Physiology*—a worthy inauguration volume of a series yet to be printed. The subject-matter of this volume is Cellular Organization and Respiration—both very fundamental aspects of plant physiology. In the successor volumes we are promised the other aspects: Vol. I B, Photosynthesis and Chemosynthesis; Vol. II, Plants in relation to Water and Solutes; Vol. III, Inorganic Nutrition of Plants; Vol. IV, Organic Nutrition and Metabolism; Vol. V, Analysis of Growth and Vol. VI, The Physiology of Development.

Prof. Steward's introduction to the Treatise entitled: *Plant Physiology*—The changing scene, is as educative as it could be, presenting as it were, a whole panorama of events, where the impact of physical sciences has made plant physiology the precise subject that it is today. The great achievements of Nicholas Théodore de Saussure, the author of *Recherches chimiques sur la vegetation*. Robert Brown, Schleiden and Schwann, Nageli and Hofmeister, Boussingault, Lawes and Gilbert, Sachs, Knop, Pfeffer and other 'dramatis personæ' of a whole century of dynamism in this field of science have been flashed before us making it a most eloquent reading. Prof. Stewart aptly quotes Erwin Schrödinger from his book *What is Life*—"it is by avoiding the rapid decay into the inert state of 'equilibrium', that an organism appears so enigmatic" and again "nature feeds on negative entropy" and goes on to say that negative entropy is inherent in the creation of the orderly patterns and restricted molecular movements which biological structure and organization present.

Coming to the subject-matter of the Volume under review: Chapter I is on the Plant Cell and its Inclusions by R. Brown; Chapter II on Proteins, Enzymes and the Mechanism of Enzyme Action by Birgit Vennesland and Chapter III on Cellular Respiration by David R. Goddard and Walter D. Bonner. There is a conventional author and subject index sandwiching an index to plant names at the end of the volume. All three chapters are very ably written, well illustrated and terminate in an exhaustive bibliography on the subject. I have immensely benefited by reading them.

The get-up of the book is very good although quite a few printing errors have crept in but it does not in any way distract the reader as they are scarce. The subjects chosen for this volume blend well and I warmly commend them to every student of plant physiology, whether at the Masters' level or engaged in research for reading and absorption. I should, however, add that it is an advanced treatise and is definitely for serious reading by those with a background of modern physiology.

T. S. SADASIVAN.

Advances in Agronomy, Vol. 12. Edited by A. G. Norman. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. xi + 464. Price $ 12.50.

This volume, in the series, contains eight review articles on diverse subjects. The researches conducted in the past decade on the fundamental properties of 2-layer, 3-layer, amorphous and other clays relating to cation exchange, anion sorption and sorption of organic compounds and the recent refinements in the techniques of their identification and quantitative estimation have been summarised by Rich and Thomas. In the next article Garisson, Bohart, App, Hardison and Justice have co-operated to review the progress of technical advances in seed production, testing and quality in forge seed. Nursery fertilization is as important as the fertilizer application to forest trees. Stoeckler has reviewed scientific investigations conducted on the former and Arneman on the latter subject. This is the first real assessment in this field. In line with previous regional articles the agronomy of South-west U.S.A. has been described by Fuller, McAlister and Metcalfe. Due to technological improvements South-West agriculture still continues to produce a surplus of food-fibre and live-stock in spite of substantial progressive reduction in acreage in the past two decades and increase in population. Soyabean production suffers from inconsistent response from direct fertilization and the exact knowledge of the critical periods in the life-cycle of the crop which limit productivity. Therefore, Ohlrogge has reviewed the mineral nutrition of the crop and Howell its physiology to elucidate these facts. Parr and Bertrand have reviewed literature on the factors controlling infiltration rate in the soil; the recent advances in techniques for the determination of infiltration rate and the theoretical studies on the subject. Recent information on taxonomy, general morphology; physiology and ecology, diseases and pests, weed control, breeding and genetics; cultural and manurial practices has been summarised by Fergus and Hollowell. The report on genetics and inheritance; adaptation of varieties and seed production techniques indicates substantial progress.

These reviews bring the subjects treated up-to-date. However, it should be mentioned that only few reports on foreign researches other than those in the U.S.A. have been included, particularly on red clover and technological advances in seed production and testing.

P. C. RAHEJA.

The Metabolism of Oral Tissues. (*Annals of the New York Academy of Sciences*, Vol. 85, Art. 1), 1960. Pp. 1-449. Price $ 4.50.

In spite of the rapid advances in the art and science of dentistry, the intermediary biochemical and metabolic processes responsible for the oral tissue changes in diseases of nutrition and metabolism are still largely unknown.

This monograph attempts to review, current knowledge of the mouth, over and beyond the dental apparatus and to cover the entire problem of the development, structure, environment, and metabolism of the tissues in the oral cavity.

The monograph examines all of the principal tissues that are critically involved in oral pathology, including specifically the hard tissues of the teeth—the enamel and the dentin—which are involved in teeth decay; the alveolar bone and other supporting tissues of the teeth involved in periodontal disease and malocclusion; the oral mucous membrane that may well prove to mirror, nutritional, hormonal and other metabolic disturbances and a variety of atrophic, hypertrophic and neoplastic pathology; and finally, the salivary gland structure and function related to the maintenance of health, both in the hard and soft tissues of the mouth.

The evolutionary aspects of the enamel, dentine, bone and cartilage; genetics of the oral structures; congenital malformations of the face and mouth as teratogenic effects of hypervitaminosis AD and the delicate interplay of local and systemic etiological factors in the causation of certain oral diseases, constitute the chapter on "Perspectives on oral tissue metabolism".

The discussions on cariostatic effect of phosphate and its mode of action, electron microscopic studies on the structure of the teeth, crystallographic studies of calcium carbonate phosphate and the relationship of host metabolism to dental caries present many new concepts on the physiology and structure of the teeth.

The hormonal control over the submaxillary salivary gland, aerobic oxidative metabolism and the proteolytic and amylase enzymatic activities of these glands, the important role of salivary glands in iodine metabolism and indirectly on thyroid functions, and finally the isolation of "Parotin", a salivary hormone have emphasized that the salivary glands are part and parcel of the endocrine system.

Biochemical, histochemical and electron microscopic studies relating to the tongue, oral mucosa, and the periodontal tissues, present highly informative data on keratization, leukoplasia, nutritional interrelationship to the pathological changes in the tongue and many clinical disorders associated with periodontal tissues.

M. SIRSI.

Bradley Volume. (*American Journal of Science*, Sterling Tower, New Haven, Conn.), 1961. Pp. vii + 433. Price $ 8.50.

This volume has been published by the *American Journal of Science* to Honour Prof. W. B. Bradley on his 61st birthday for the distinguished services rendered by him in the cause of Geology. Several well-known Geologists have contributed articles to this volume and have made it a very useful number.

In the first article, Prof. W. P. Woodring has given an excellent summary of the life and work of Prof. Bradley. There are thirty-seven other articles covering a very wide range of subjects in Geology, like igneous, sedimentary and metamorphic petrology, Mineralogy, Palæontology, Palæobotany, Stratigraphy, Geomorphology and Structural geology. Although many of the articles deal with American geology, the conclusions arrived at are of wider geological interest. A few of the articles like 'The nature of residual liquids from crystallisation with data on the system—mepheline-diopside-silica' by F. M. Schairer and H. S. Yoder and 'Notes on the measurements of faunal resemblance' by G. S. Simpson and 'A new method of plotting chemical analyses of basaltic rocks' by K. G. Murata are of a specialised type undertaken as original investigations and are of interest to all geologists.

In collecting and publishing such a large number of articles, the *American Journal of Science* has paid a tribute to Prof. Bradley in his sixty-first birthday and has also provided the geologists all the world over with plenty of useful geological information.

M. R. S.

Cytogenetics and Plant Breeding. By N. Krishnaswamy and S. N. Chandrasekharan (P. Varadachary and Co., Madras-1), 1960. Pp. xv + 653. Price Rs. 25.

The book is the revised and enlarged edition of the book by S. N. Chandrasekharan and S. V. Parthasarathy first published in 1948 and reprinted with small additions in 1953. The book when first published met a long felt need for a text-book on genetics with data obtained in tropical crops with which the students could be expected to be familiar. This second edition which is an improvement on the first contains many new features. In addition to some rearrangement of the subject-matter, new chapters on Allelism, Sex-inheritance in plants, Cytoplasmic inheritance and heterosis have been introduced. The lists of linkage values, gene symbols and chromosome numbers have been made more comprehensive and brought up to date. It has however to be mentioned that they are not final. The gene symbolization in use in rice is still confusing and is being revised for acceptance on an international basis.

As mentioned by Dr. Pal in his foreword, recognition of the genes by which transmission takes place has so altered the ideas and experimental methods employed in animal and plant breeding and in medicine that genetics can now be regarded as the axis in the conceptional structure of biology. New experimental techniques have become available to the investigator, and intensive work is in progress. It may be remarked that the book does not do full justice to such recent work. The book is published in 1960 and contains over 700 references in bibliography but hardly a hundred of them refer to publications subsequent to 1950 except in cases where the senior author was himself interested in.

On page 334 the reference must be to *Oryza officinalis* and not to *Oryza latifolia*. Similarly, *O. perennis* might have been used instead of the old *O. longistaminata*. Brief additional information on biochemical concept of gene, nature of action of new mutagens, photoperiodism, embryoculture, concept of geographical races in relation to practical breeding, use of discriminant function, modification in pedigree breeding, etc., could have made the book more useful for post-graduate students.

The authors of the book have been associated with teaching of genetics and cytology for several years in the Agricultural College, Coimbatore, and the senior author has built up an active section on cytogenetics at the post-graduate level in the same institute, and they may be

congratulated on the successful work they have accomplished in publishing this text-book. The book is sure to be welcomed even outside India, in countries of the near and far east where teaching of genetics in the local Agricultural Colleges is receiving greater attention.

K. R.

Introduction to Physical Chemistry, Vol. III. By S. N. Mukherjee. (Art Union, 55/7, Grey Street, Calcutta-6), 1960. Pp. xi + 832. Price Rs. 25.

The book is intended to be an introductory text-book on Physical Chemistry for post-graduate students of Indian Universities. It is an extension of the author's first two volumes prepared for undergraduate courses, and the continuity of the numbering of the chapters (XLII-LII) has been maintained. In writing the book the author seems to have had the conventional post-graduate syllabus of an Indian University before him. The author has taken considerable pains to collect his materials from different well-known text-books and present them in a manner which is sure to appeal to average students who have in view the passing of a University examination. Teachers also new to the profession, will find "ready-made" material for their class-room lectures. However, to gain clear and fundamental knowledge on the subject the students should supplement their reading by referring to the more standard books on the various topics dealt with here.

A. S. G.

Indian Standards Institution, *Thirteenth Annual Report*. (Indian Standards Institution (ISI), Manak Bhavan, New Delhi-1], 1950-60. Pp. 127. Price Rs. 2.

The Indian Standards Institution was set up in 1947, in pursuance of a decision of the Government of India, for the purpose of preparing and promoting standards for Indian Industry. The objects of ISI include the preparation, promotion and general adoption, at the national and international levels, of standards, relating to materials, commodities, structures, practices and operations. It promotes quality control methods, and provides for the registration of Standard Marks conforming to standards issued by it.

The *Thirteenth Annual Report* which we have received contains in detail the work of the various Divisions of the Institution during 1959-60. A perusal of the report shows a rapid increase in the activities of the Institution. During the year 216 new standards and 22 revised standards were issued by the ISI as against 196 in the previous year.

Books Received

Quantum Mechanics. By J. L. Powell and B. Crasemann. (Addison-Wesley Publishing Co., Reading, Mass., U.S.A.), 1961. Pp. x + 495. Price $ 9.75.

Selected Papers on Stress Analysis—The Institute of Physics Stress Analysis Group Conference, Delft, 1959. (Chapman and Hall, 37, Essex Street, London, W.C. 2), 1961. Pp. 114. Price 50 *sh*.

Introduction to Probability and Random Variables. By G. P. Wadsworth and J. G. Bryan. (McGraw Hill Book Co., 330, West, 42nd Street, New York), 1960. Pp. vii + 292. Price $ 8.75.

The Chemistry of Heterocyclic Compounds (Vol. 15)—*Heterocyclic Compounds with Bridgehead Nitrogen Atoms* (Part I). By William L. Mosby. (Interscience Publishers, 250, Fifth Avenue, New York-1), 1961. Pp. 747. Price $ 48.00; Subn. $ 43.00.

The Indian Ephemeris and Nautical Almanac for the Year 1962. (Nautical Almanac Unit, Regional Meteorological Centre, Alipore, Calcutta-27), 1961. Pp. xxviii + 460. Price Rs. 14.

Cambridge Monographs in Experimental Biology, No. 11—Intermediary Metabolism Plants. By David D. Davies. (The Cambridge University Press, 200, Euston Road, London, N.W. 1), 1961. Pp. xii + 107. Price 20 *sh*.

Applied Thermodynamics. By S. H. Bransom. (D. Van Nostrand Co. Ltd., 358, Kensington High Street, London, W. 14), 1961. Pp. vii + 230. Price 30 *sh*.

The New Age in Physics. By H. S. W. Massey. (Elek Books Ltd., 14, Great James Street, London, W.C. 1), 1960. Pp. 342. Price 42 *sh*.

Progress in Cryogenics (Vol. 3). By K. Mendelssohn. (Heywood and Co., Ltd., London), 1961. Pp. 173. Price 45 *sh*.

Physics of the Solar Chromosphere (Vol. VI). By R. N. Thomas and R. G. Athay. (Interscience Publishers, New York), 1961. Pp. x + 422. Price $ 15.50.

Differential Equations. By F. G. Tricomi. (Blackie and Son Ltd., 16-18, William IV St., London, W.C. 2), 1961. Price 50 *sh*.

Boundary and Eigenvalue Problems in Mathematical Physics. By Hans Sagan. (John Wiley and Sons, London; India: Asia Publishing House, Bombay-1), 1961. Pp. xviii + 381.

SCIENCE NOTES AND NEWS

Seminar on Electrochemistry

The Third Seminar on Electrochemistry will be held during the third week of December 1961, at the Central Electrochemical Research Institute, Karaikudi.

Three copies of detailed abstracts of papers (not exceeding 300 words) proposed to be contributed may kindly be forwarded to the Convener of the Seminar, Mr. V. Aravamuthan, Assistant Director, Central Electrochemical Research Institute, Karaikudi-3 (Madras State), not later than 15th September 1961 and two copies of the full papers by the 15th November 1961.

Raptakos Medical Research Fellowships

The Raptakos Medical Research Board will consider applications for the award of Fellowships for research work on medical and allied subjects in recognized institutions situated in the Union of India. The awards normally consist of Rs. 3,000 per year for a Fellowship and Rs. 750 per year towards contingencies approved by the Board.

Applications in the prescribed form, which may be obtained from the Secretary and Treasurer, should be forwarded through the Guides, under whom research work will be carried out, and the Heads of the Institutions. Each application should be accompanied by six copies of a brief statement of the research project and the comments of the guide regarding the suitability of the project and the facilities existing at the Institution. Applicants should have an M.B., B.S. or M.Sc. Degree or its equivalent or not less than two years' experience in research work after B.Sc. The awards are made annually and may be renewed on the basis of satisfactory progress.

Application for grants for the year commencing January 1, 1962 should reach the Secretary and Treasurer, Raptakos Medical Research Board, Dr. Annie Besant Road, Worli, Bombay-18, before September 30, 1961.

Symposium on Carbohydrate, Cellulose and Cellulose Industries

The Chemical Research Committee of C.S.I.R. is organising a Symposium on Carbohydrates, Cellulose and Cellulose Industries on the 29th and 30th January, 1962 at the Ahmedabad Textile Industry's Research Association, Ahmedabad-9.

The programme will consist of presentation and discussion of original research work in the following fields: (*i*) Chemistry and Biosynthesis of Carbohydrates; (*ii*) Physics and Chemistry of Natural Cellulosic Fibres; (*iii*) Chemistry and Technology of Cellulosic Fibres, Paper and Rayon Pulp and Cellulose Derivatives. Research workers are invited to correspond with the Director, Ahmedabad Textile Industry's Research Association, Ahmedabad-9.

The Indian Pharmaceutical Congress

The Fourteenth Session of the Indian Pharmaceutical Congress will be held at Cuttack during December 29-31, 1961.

For particulars please write to the Honorary General Secretary, Indian Pharmaceutical Congress Association, 14, Ganesh Chandra Avenue, Calcutta-13.

Micro Hydel Sets to Harness Hill Streams for Power Generation

One of the significant developments in the field of power generation in 1960-61 is the harnessing of hill streams fed by glaciers, producing enough electric power for groups of villages in remote areas in the country. During the Second Plan a micro or baby hydel set was installed at Chaila, in Himachal Pradesh, on an experimental basis, for harnessing the waters of the Giriganga, about 18 miles from Simla. This power house has been meeting the demands for electricity from the nearby villages, and a second set is being installed in the Bharmour valley in Chamba District and another is being planned for Chini in 1961-62. In the Third Plan period, it is proposed to instal 13 micro sets in Himachal Pradesh. The head required for these micro sets is low—a maximum of 25 ft. with adequate water flow. These stations would operate either unattended or attended by junior line staff for continuity of supply.—(*Press Information Bureau, Government of India.*)

Gamma-Radiation to Control Timber Pest

British timber experts have been investigating the possibility of controlling the death-watch beetle by gamma-radiation treatment.

Blocks of oak sapwood containing active larvæ were given dosages varying from 4,000

to 8,000 rœntgens. Some beetles survived the 4,000-rœntgen treatment and subsequently emerged and laid eggs, but only a few of the eggs hatched. However, the stronger dosages (6,000 rœntgens upwards) appeared to be fatal, as no beetles emerged from the treated blocks.—(*British Information Services.*)

New Standard for the Metre

In its original conception the meter was the fundamental unit of the metric system, and all units of length were to be derived directly from the meter which was intended to be equal to one ten-millionth of the earth's quadrant.

In October 1960, it was agreed at the Eleventh General (International) Conference on Weights and Measures to redefine the meter in terms of the wavelength of the orange-red radiation in vacuum of krypton 86 corresponding to the unperturbed transition between the $2p_{10}$ and $5d_5$ levels as follows:

1 meter = 1,650,763·73 wavelengths.

This corresponds to a wavelength (krypton 86 orange-red) of

$6{,}057{\cdot}8021 \times 10^{-7}$ millimeter.

Thus, as for more than 150 years, the meter bears no definite relation to the earth's quadrant. From the time of the adoption of the International Prototype Meter in 1889, the meter had been defined in terms of that standard, a platinum-iridium bar kept at the International Bureau of Weights and Measures in Sevres, France, suburb of Paris. At the Seventh General Conference in 1927 a supplementary relation between the meter and the wavelength of light was adopted. This relation for red cadmium light waves under specified conditions of temperature, pressure, and humidity was: 1 meter = 1,553,164·13 wavelengths. This corresponds to a wavelength (cadmium red) of $6{,}438{\cdot}4696 \times 10^{-7}$ millimeter. The number of wavelengths of the krypton 86 radiation in one meter, 1,650,763·73, was obtained by comparing interferometrically orange-red krypton 86 radiation with the red cadmium radiation.

The above is extracted from the latest publication *Units of Weights and Measures*, National Bureau of Standards Miscellaneous Publication 233 (Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.), 1960, 20 pages, 40 cents.

Effects of High Pressure on Glass: A Possible Piezometer for the 100-Kilobar Region

The measurement of pressures of the order of 10,000–200,000 bars and upward on uniaxial pressure transmitting devices is a formidablename problem. At present, high-pressure calibration devices depend on the temperature-dependent phase transitions which occur in some metals. This is unsatisfactory, since it allows only pointwise calibration over a limited range of pressures and is limited to the room-temperature 'fixed' points.

Bridgman and Simon found that silica glass could, above a threshold pressure of about 100,000 atmospheres, be made permanently more dense and at pressures of about 200,000 atmospheres this increase in density amounted to about 6-7%.

In their recent investigations of the problem Rustom Roy and H. M. Cohen find the effect of pressure on the density and refractive index of silica glass to be much greater than that reported by Bridgman and Simon. Further, the change in density was found to be a continuous function of pressure above 20,000 atmospheres at room temperature. No threshold effect was observed at 600° C. The density of silica glass, which has a normal refractive index of 1·458, could be increased by a pressure of 150,000 atmospheres at room temperature to a form with a refractive index as high as α-quartz, namely, 1·54. The changes achieved by Bridgman and Simon at a reported pressure of 200,000 atmospheres could be achieved at pressures as low as 55,000 atmospheres at room temperature.

In view of the observed continuous increase of density of silica glass as a function of both temperature and pressure, it is proposed that the refractive index of silica glass be used as a piezometer. Silica is particularly inert and could be mixed with many samples to provide a check on the actual pressure and/or temperature of a run. It is suggested that it would be quite valuable if several laboratories interested in high-pressure measurements determined independently the effect of pressure and temperature on the refractive index of silica glass. Perhaps a satisfactory pressure-scale could then be agreed upon.—(*Nature*, 1961, 190, 798.)

Element 103, Lawrencium

A group of nuclear scientists of the Lawrence Radiation Laboratory, University of California, succeeded in obtaining the new element 103 by bombarding californium with boron nuclei B^{10}, B^{11}, in the laboratory's heavy-ion linear accelerator. The name *Lawrencium* has been proposed to the new element in honour of E. O. Lawrence, the inventor of the cyclotron and founder of the laboratory which bears his

Californium (element 98), used as the target material in the synthesis of the new element, is obtained by prolonged irradiation of trans-uranium elements in a nuclear reactor by the successive addition of neutrons. Since each new heavy element is more unstable than the one before, neutron addition method will become increasingly inapplicable, and heavy-ion bombardment is the more promising route whereby heavy elements may be created. Even by this method it is improbable that elements beyond 105 will be produced and identified, because of their extreme instability and of the very small number of atoms formed in the reaction.

The discovery of Lawrencium, the eleventh new man-made element after uranium (92), was announced on April 13, 1961 by the University of California and the U.S. Atomic Energy Commission.

Hydrogen Lines in the Infra-Red Spectrum of the Sun from High-Flying Aircraft

Solar spectra taken with a high-resolution spectrograph from an aircraft flying at altitudes of 30-40 thousand feet have revealed the presence of atomic hydrogen lines in the infra-red due to absorption in the solar atmosphere. Two of these lines occurring in the water-vapour band 1·9 μ have been identified as the first line of the Paschen series (electronic transition 3-4) and the fourth line of the Brackett series (4-8). Another solar line that has been detected is the second line of the Brackett series (transition 4-6), lying in the 2·6 μ water band.

These features have been experimentally observed for the first time. They are not revealed in the solar spectrum taken from ground level on account of the strong absorption in the infra-red region shown by the constituents of the earth's atmosphere. Even in spectra taken at mountain observatories these lines are obscured by the water-vapour absorption.

The intensity of these lines have been observed to be the same on spectra taken at different high altitudes thus confirming their solar origin.

In calculating water-vapour concentrations from absorption photometry due account should be taken of the presence of these lines.—(*Nature*, 1961, 189, 908.)

Infra-Red Physics—*An International Research Journal* (Vol. 1, No. 1). (Pergamon Press Ltd., Headington Hill Hall, Oxford), March 1961. Annual Subscription £ 7. ($ 20.00).

This new journal is being established as an international forum for the publication of scientific papers devoted to infra-red physics and its applications. It is concerned with infra-red theory, experiment, and instrumentation as applied to infra-red detection and transmission and to problems of atmospheric, meteorological, geophysical, astrophysical and space research.

Fittingly enough the first number of the journal opens with an article on the life and work of Sir William Herschel. Among the other articles in this issue are: "A status report on infra-red detectors" by P. Bratt, W. Engeler, H. Levinstein, A. MacRae and J. Pehek; "Interferenz-Modulation mit monochromatischen Millimeter-Wellen" by H. Happ and L. Genzel; "Sunseeker for high-altitude infra-red solar spectra" by P. A. Lapp and H. S. Kerr; "Infra-red photography using persistent internal polarization in phosphor plates" by H. Kallmann, J. Rennert and M. Sidran; "The theory of thermal imaging, and its application to the absorption-edge image-tube" by C. Hilsum and W. R. Harding.

The annual subscription is £ 7 ($ 20.00) for institutions and £ 3-10 *sh.* ($ 10.00) for individuals.

ERRATUM

In the June, 1961, issue of *Current Science*, on page 224, column 2nd, paragraph 2nd, the 5th line should read as '*C. neoformans* from the sputum of a human case' and not, '*C. diffluens*, *C. laurentii* and *C. luteolus* to be'.

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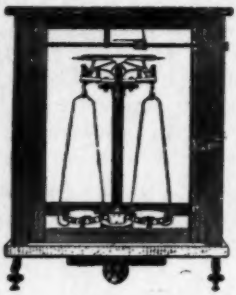

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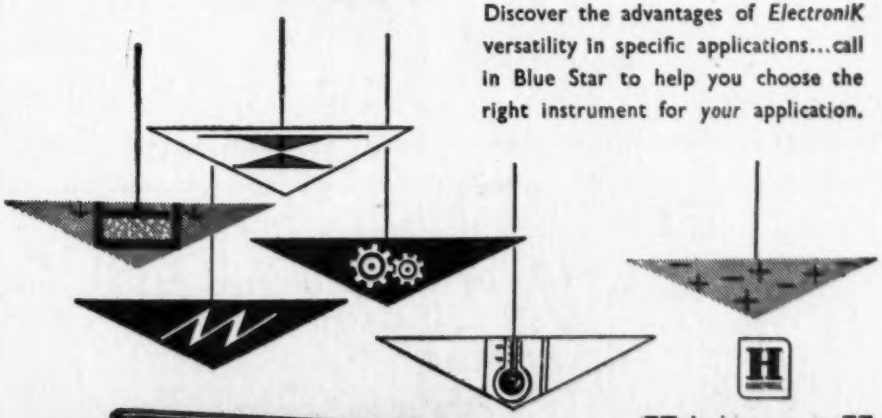

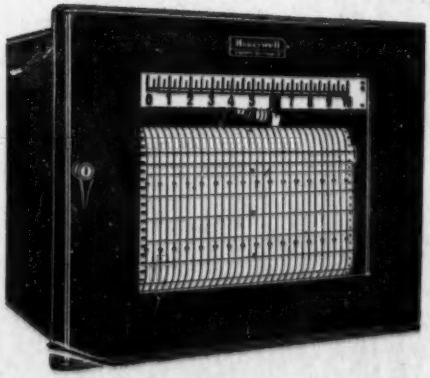

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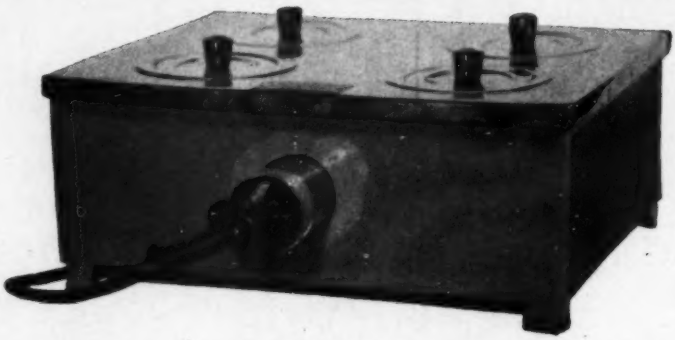

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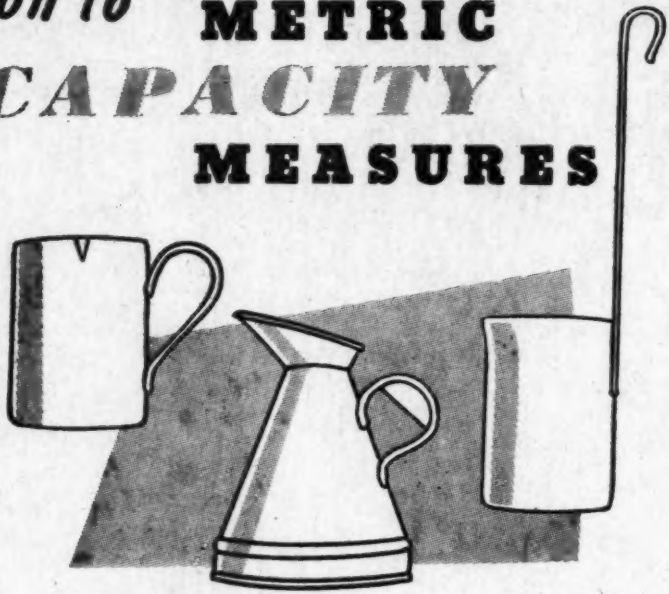

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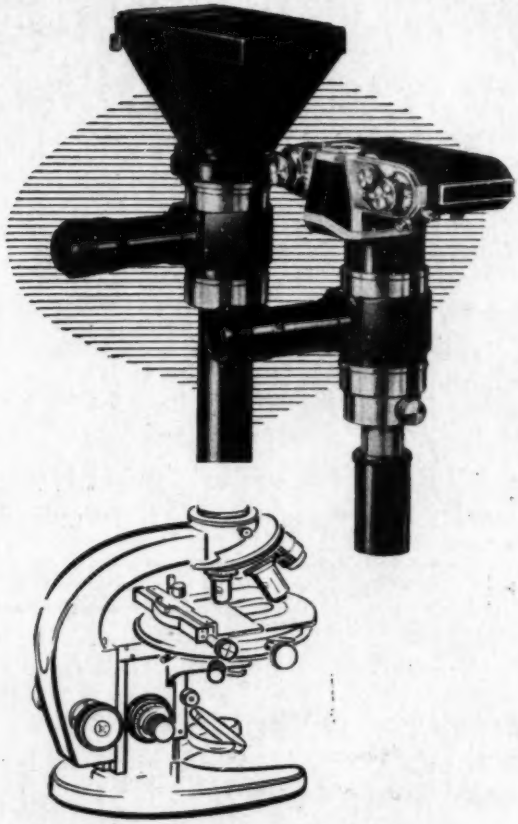

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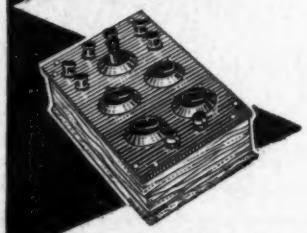

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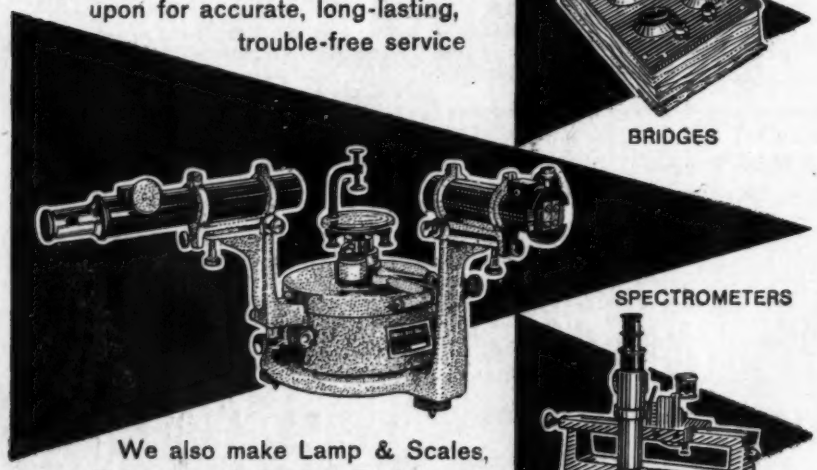

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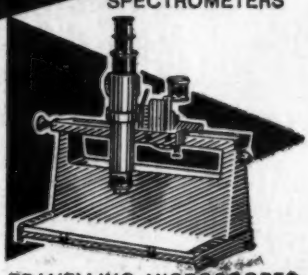

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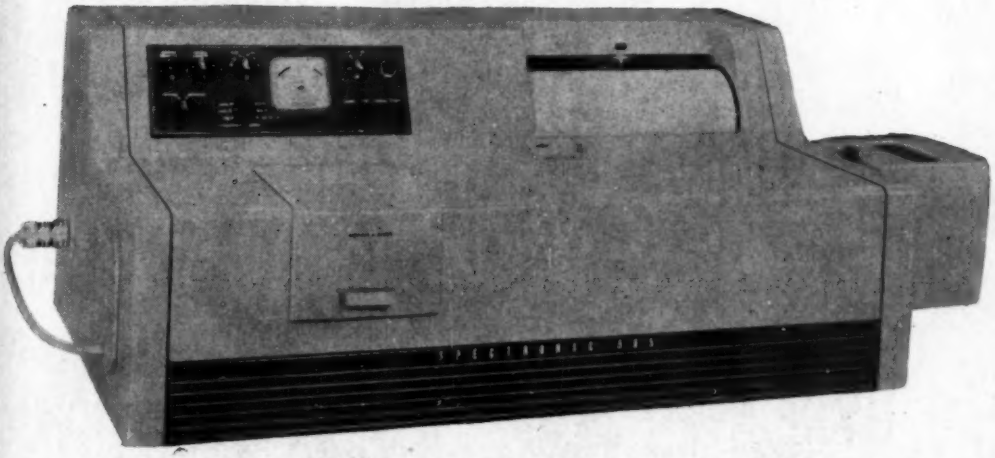

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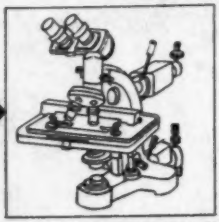

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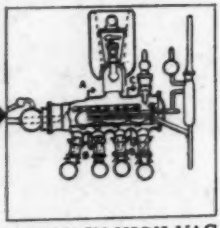

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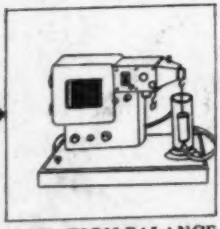

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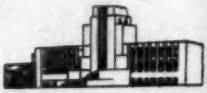

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